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SUSTAINABLE ENERGY TRAINING CENTER

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DELAWARE TECHNICAL & COMMUNITY COLLEGE

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SECTION 024500 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:
1. Division 7 Section "Through-Penetration Firestop Systems" for patching fire-rated construction.
2. Divisions 2 through 49 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

    a. Requirements in this Section apply to mechanical and electrical installations. Refer to Divisions 21 thru 28 Sections for other requirements and limitations applicable to cutting and patching mechanical and electrical installations.

1.3 DEFINITIONS

A. Cutting: Removal of existing construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to Existing Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.

3. Utilities: List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out of service. Indicate how long service will be disrupted.
4. Architect's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 QUALITY ASSURANCE

A. Retain experienced and specialized Installer or fabricator to cut and patch the Work listed below.

B. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

C. Operational Elements: Do not cut and patch the following operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

1. Primary operational systems and equipment.
2. Air or smoke barriers.
3. Fire-protection systems.
4. Control systems.
5. Communication and data systems.
6. Electrical wiring systems.
7. Operating systems of fire alarm and building automation systems.

D. Miscellaneous Elements: Do not cut and patch the following elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

1. Water, moisture, or vapor barriers.
2. Exterior curtain-wall construction.
3. Equipment supports.
4. Piping, ductwork, vessels, and equipment.
5. Noise- and vibration-control elements and systems.

E. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

1. Stonework and brick masonry.
2. Preformed metal panels
3. Firestopping.
4. Window wall system.
5. Acoustical ceilings.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections of these Specifications.

B. Existing Materials: Use materials identical to existing materials. For exposed surfaces, use materials that visually match existing adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of existing materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Services: Where existing services are required to be removed, relocated, or abandoned, bypass such services before cutting to avoid interruption of services to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut existing construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

2. Do not cut structural or load bearing elements unless specifically noted on structural or demolition drawings. Structural elements include: steel columns, beams, bar joists, concrete beams, columns; floor slabs, footings.

B. Cutting: Cut existing construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Existing Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Division 2 Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or re-hang existing ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather-tight condition.

END OF SECTION 024500

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:

1. Footings.
2. Foundation walls.
3. Slabs-on-grade.
4. Suspended slabs.

B. Related Sections include the following:

1. Section 017419 - Construction Waste Management.
2. Section 018113 – Sustainable Design Requirements.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

D. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Provide elevation drawings for all reinforced concrete walls.

E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly, and support of formwork.

1. Shoring and Re-shoring: Indicate proposed schedule and sequence of stripping formwork, shoring removal, and installing and removing re-shoring.

F. Welding certificates.

G. Qualification Data: For Installer, manufacturer, and testing agency.

H. Material Test Reports: For the following, from a qualified testing agency, indicating compliance with requirements:

1. Aggregates.

I. Material Certificates: For each of the following, signed by manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Steel reinforcement and accessories.
5. Fiber reinforcement.
6. Waterstops.
7. Curing compounds.
8. Floor and slab treatments.
9. Bonding agents.
10. Adhesives.
11. Vapor retarders.
12. Joint-filler strips.
13. Repair materials.

J. Floor surface flatness and levelness measurements to determine compliance with specified tolerances.

K. Field quality-control test and inspection reports.

L. Minutes of pre-installation conference.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Finisher/Technician.

B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

C. Testing Agency Qualifications: The Owner will engage an independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.

D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

E. Welding: Qualify procedures and personnel according to AWS D1.4, "Structural Welding Code--Reinforcing Steel."

F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:

1. ACI 301, "Specification for Structural Concrete."
2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."

G. Concrete Testing Service: The Owner will engage a qualified independent testing agency to perform material evaluation tests.

H. Mockups: Cast concrete slab-on-grade panels to demonstrate typical joints, surface finish, texture, tolerances, and standard of workmanship.

1. Build panel approximately 200 sq. ft. (18.6 sq. m) for slab-on-grade in the location indicated or, if not indicated, as directed by Architect.

2. Approved panels may become part of the completed Work if undisturbed at time of Substantial Completion.

I. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:

a. Contractor's superintendent.
b. Independent testing agency.
c. Ready-mix concrete manufacturer.
d. Concrete subcontractor.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

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 FORM-FACING MATERIALS

A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.

1. Plywood, metal, or other approved panel materials.
2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:

    a. High-density overlay, Class 1 or better.
    b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    c. Structural 1, B-B or better; mill oiled and edge sealed.
    d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.

B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

C. Forms for Cylindrical Columns, Pedestals, and Supports: Metal, glass-fiber-reinforced plastic, paper, or fiber tubes that will produce surfaces with gradual or abrupt irregularities not exceeding specified formwork surface class. Provide units with sufficient wall thickness to resist plastic concrete loads without detrimental deformation.

D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1/2 by 1/2 inch (19 by 19 mm), minimum.

E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

1. Formulate form-release agent with rust inhibitor for steel form-facing materials.

F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.

1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of exposed concrete surface.
2. Furnish ties that, when removed, will leave holes no larger than 1 inch (25 mm) in diameter in concrete surface.
3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

2.3 STEEL REINFORCEMENT

A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 90 percent.

B. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

C. Epoxy-Coated Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed bars, ASTM A 775/A 775M, epoxy coated, with less than 2 percent damaged coating in each 12-inch (300-mm) bar length.

D. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 ASTM A 706/A 706M, deformed bars, assembled with clips.

E. Plain-Steel Wire: ASTM A 82, as drawn.

F. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

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

B. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A 775/A 775M.

C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:

1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

2.5 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:

1. Portland Cement: ASTM C 150, Type I:

   a. Fly Ash: ASTM C 618, Class F.
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Silica Fume: ASTM C 1240, amorphous silica.

C. Normal-Weight Aggregates: ASTM C 33, Class **3**M coarse aggregate or better, graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: Provide maximum coarse aggregate size permitted for specific concrete mix design.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

D. Water: ASTM C 94/C 94M; potable.

2.6 ADMIXTURES

A. Air-Entraining Admixture: ASTM C 260.

B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

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

C. Color Pigment: ASTM C 979, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, nonfading, and resistant to lime and other alkalis.

1. Available Manufacturers:

a. Bayer Corporation.
b. ChemMasters.
c. Conspec Marketing & Manufacturing Co., Inc.; a Dayton Superior Company.

2. Color: As selected by Architect from manufacturer's full range.

2.7 WATERSTOPS

A. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch (19 by 25 mm).

1. Available Products:

a. Colloid Environmental Technologies Company; Volclay Waterstop-RX.
b. Concrete Sealants Inc.; Conseal CS-231.
c. Greenstreak; Swellstop.

2.8 VAPOR RETARDERS

A. Plastic Vapor Retarder: ASTM E 1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.

1. Available Products:

   a. Fortifiber Corporation; Moistop Ultra A.
   b. Raven Industries Inc.; Vapor Block **15**.
   c. Stego Industries, LLC; Stego Wrap, 15 mils.

2.9 FLOOR AND SLAB TREATMENTS

A. MANUFACTURERS

1. Basis-of-Design: Epmar Corporation; 13240 E. Barton Circle, Santa Fe Springs, CA 90605. ASD, tel: (562) 946-8781. Fax: (562) 944-9958. Email epmar@quakerchem.com. Web: http://www.epmar.com. www.kemiko.com www.rapidshield.com

B. CONCRETE FLOOR STAIN

1. Product: Kemiko Stone Tone Stain as manufactured by Epmar Corporation. Type: Combination of acid solution, wetting agents, and metallic ions. When mixed with water, chemically combines with Portland cement to form permanent colors.

   a. Color: Cola

   b. Color: Golden Wheat

2.10 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.

B. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

C. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

D. Reglets: Fabricate reglets of not less than 0.0217-inch- (0.55-mm-) thick, galvanized steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.

E. Dovetail Anchor Slots: Hot-dip galvanized steel sheet, not less than 0.0336 inch (0.85 mm) thick, with bent tab anchors. Provide dovetail anchor slots with temporarily foam fill in slots to prevent intrusion of all concrete or debris.

2.11 REPAIR MATERIALS

A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
4. Compressive Strength: Not less than 4100 psi (29 MPa) at 28 days when tested according to ASTM C 109/C 109M.

B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.

1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

2.12 CONCRETE MIXTURES, GENERAL

A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.

1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.

B. Cementitious Materials: Use fly ash, pozzolan, ground granulated blast-furnace slag, and silica fume as needed to reduce the total amount of portland cement. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash: 25 percent.
2. Combined Fly Ash and Pozzolan: 25 percent.
3. Ground Granulated Blast-Furnace Slag: 30 percent.

C. Admixtures: Use admixtures according to manufacturer's written instructions.

1. Use admixtures in concrete, as required, for placement and workability.
2. Water-reducing and retarding admixtures may be used when required by high temperatures, low humidity, or other adverse placement conditions.

3. Use water-reducing admixture in pumped concrete and in concrete with a water-cement ratio below 0.50.
4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

D. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.

2.13 CONCRETE MIXTURES FOR BUILDING ELEMENTS

A. Footings: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3000 psi (20.7 MPa) at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 3 inches (75 mm) to 5 inches (125 mm).
4. Air Content: 5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.

B. Foundation Walls: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
2. Maximum Water-Cementitious Materials Ratio: 0.50.
3. Slump Limit: 3 inches (75 mm) to 5 inches (125 mm).
4. Air Content: 5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.

C. Interior Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:

1. Minimum Compressive Strength: 3500 psi (24.1 MPa) at 28 days.
2. Maximum Cementitious Materials Content: 520 lb/cu. yd. (309 kg/cu. m).
3. Maximum Water-Cementitious Materials Ratio: 0.50.
4. Slump Limit: 5 inches (125 mm) maximum.
5. Air Content: Do not add air-entrainment admixture.
6. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate.

D. Exterior Slabs on Grade: Proportion normal-weight concrete mixtures as follows:
1. Minimum Compressive Strength: 4500 psi (31 MPa) at 28 days.
2. Maximum Cementitious Materials Content: 520 lb/cu. yd. (309 kg/cu. m).
3. Maximum Water-Cementitious Materials Ratio: 0.45.
4. Slump Limit: 5 inches (125 mm) maximum.
5. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.

2.14 FABRICATING REINFORCEMENT

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

2.15 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M, and furnish batch ticket information.

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

B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. (0.76 cu. m) or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd. (0.76 cu. m), increase mixing time by 15 seconds for each additional 1 cu. yd. (0.76 cu. m).
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

PART 3 - EXECUTION

3.1 FORMWORK

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

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

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

1. Class A, 1/8 inch (3.2 mm) for smooth-formed finished surfaces.
2. Class B, 1/4 inch (6 mm) for rough-formed finished surfaces.

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

E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

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

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

G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.

H. Chamfer exterior corners and edges of permanently exposed concrete.

I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.

K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.

L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

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

1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
3. Install dovetail anchor slots in concrete structures as indicated.

3.3 REMOVING AND REUSING FORMS

A. General: Formwork for sides of beams, walls, piers, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 48 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.

B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.

C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 SHORES AND RESHORES

A. Comply with ACI 318 (ACI 318M) and ACI 301 for design, installation, and removal of shoring and reshoring.

1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.

B. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

3.5 VAPOR RETARDERS

A. Plastic Vapor Retarders: Place, protect, and repair vapor retarders according to ASTM E 1643 and manufacturer's written instructions.

1. Lap joints 6 inches (150 mm) and seal with manufacturers recommended tape.

3.6 STEEL REINFORCEMENT

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

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.

C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.

1. Weld reinforcing bars according to AWS D1.4, where indicated.

D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.

E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

3.7 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.

1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
4. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
5. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
6. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-third of concrete thickness as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch (3.2 mm). Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.

D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
2. Terminate full-width joint-filler strips not less than 1/2 inch (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 7 Section "Joint Sealants," are indicated.
3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

E. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.

3.8 WATERSTOPS

A. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

3.9 CONCRETE PLACEMENT

A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.

B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.

C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.

1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.

D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.

1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
2. Maintain reinforcement in position on chairs during concrete placement.
3. Screed slab surfaces with a straightedge and strike off to correct elevations.
4. Slope surfaces uniformly to drains where required.

5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

G. Hot-Weather Placement: Comply with ACI 301 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.10 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

1. Apply to concrete surfaces not exposed to public view.

B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.

C. Rubbed Finish: Apply the following to smooth-formed finished as-cast concrete where indicated:

1. Smooth-Rubbed Finish: Not later than one day after form removal, moisten concrete surfaces and rub with carborundum brick or another abrasive until producing a uniform color and texture. Do not apply cement grout other than that created by the rubbing process.
2. Grout-Cleaned Finish: Wet concrete surfaces and apply grout of a consistency of thick paint to coat surfaces and fill small holes. Mix one part portland cement to one and one-half parts fine sand with a 1:1 mixture of bonding admixture and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match

adjacent surfaces. Scrub grout into voids and remove excess grout. When grout whitens, rub surface with clean burlap and keep surface damp by fog spray for at least 36 hours.

3. Cork-Floated Finish: Wet concrete surfaces and apply a stiff grout. Mix one part portland cement and one part fine sand with a 1:1 mixture of bonding agent and water. Add white portland cement in amounts determined by trial patches so color of dry grout will match adjacent surfaces. Compress grout into voids by grinding surface. In a swirling motion, finish surface with a cork float.

D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.11 FINISHING FLOORS AND SLABS

A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch (6 mm) in 1 direction.

1. Apply scratch finish to surfaces [**indicated**]

C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.

1. Apply float finish to surfaces [**indicated**]

D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.

1. Apply a trowel finish to surfaces [**indicated**]
2. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:

    a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15.
    b. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
    c. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.

d. Specified overall values of flatness, F(F) 45; and of levelness, F(L) 35; with minimum local values of flatness, F(F) 30; and of levelness, F(L) 24.

3. Finish and measure surface so gap at any point between concrete surface and an unleveled, freestanding, 10-foot- (3.05-m-) long straightedge resting on 2 high spots and placed anywhere on the surface does not exceed [**1/4 inch (6 mm)**] [**3/16 inch (4.8 mm)**] [**1/8 inch (3.2 mm)**]

E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces [**indicated**]. While concrete is still plastic, slightly scarify surface with a fine broom.

1. Comply with flatness and levelness tolerances for trowel finished floor surfaces.

F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.

1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

3.12 MISCELLANEOUS CONCRETE ITEMS

A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.

B. Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.

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

D. Steel Pan Stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel-finish concrete surfaces.

3.13 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and

during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.

D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.

E. Cure concrete according to ACI 308.1, by one or a combination of the following methods. **All concrete slabs shall be initially moist-cured by either Method 1 or Method 2 for a minimum of seven (7) days.**

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

   a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
   b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
   c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project..

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

   a. After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.

4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial

application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.14 LIQUID FLOOR TREATMENTS

A. Penetrating Liquid Floor Treatment: Prepare, apply, and finish penetrating liquid floor treatment according to manufacturer's written instructions.

1. Remove curing compounds, sealers, oil, dirt, laitance, and other contaminants and complete surface repairs.
2. Do not apply to concrete that is less than 28 days old. Apply in accordance with manufacturer’s recommendations.
3. Apply liquid until surface is saturated, scrubbing into surface until a gel forms; rewet; and repeat brooming or scrubbing. Rinse with water; remove excess material until surface is dry. Apply a second coat in a similar manner if surface is rough or porous.

B. Sealing Coat: Uniformly apply a continuous sealing coat of curing and sealing compound to hardened concrete by power spray or roller according to manufacturer's written instructions.

3.15 JOINT FILLING

A. Prepare, clean, and install joint filler according to manufacturer's written instructions.

1. Do not fill joints until construction traffic has permanently ceased.

B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.

3.16 CONCRETE SURFACE REPAIRS

A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.

B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.

C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.

1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch (13 mm) in any dimension in solid concrete, but not less than 1 inch (25 mm) in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.

2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.

D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch (0.25 mm) wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
2. After concrete has cured at least 14 days, correct high areas by grinding.
3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch (6 mm) to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
6. Repair defective areas, except random cracks and single holes 1 inch (25 mm) or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch (19-mm) clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
7. Repair random cracks and single holes 1 inch (25 mm) or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.

F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.17 FIELD QUALITY CONTROL

A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform special inspections in accordance with the applicable portions of Table 1704.4 (Required Verification and Inspection of Concrete Construction) of the 2006 International Building Code, and prepare test reports.

B. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

3. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
4. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
5. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
6. Unit Weight: ASTM C 567, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
7. Compression Test Specimens: ASTM C 31/C 31M.

    a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.

8. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.

    a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.
    b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.

10. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
11. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
12. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
13. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.

C. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 48 hours of finishing.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes unit masonry assemblies consisting of the following:

1. Concrete masonry units (CMUs).
2. Face brick, including special shapes.
3. Mortar and grout.
4. Reinforcing steel.
5. Masonry joint reinforcement.
6. Ties and anchors.
7. Embedded flashing.
8. Miscellaneous masonry accessories.
9. Rigid insulation at masonry cavity-walls
10. Date stone (Cornerstone)
11. Stencil ID on rated walls.

B. Related Sections include the following:

1. Division 7 Section "Bituminous Dampproofing" for dampproofing applied to cavity face of backup wythes of cavity walls.
2. Division 7 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
3. Division 7 Section "Through-Penetration Firestop Systems" for firestopping at openings in masonry walls. and for fire-resistive joint systems at heads of masonry walls.
4. Division 7 Section "Fire-Resistive Joint Systems" for fire-resistive joint systems at heads of masonry walls.
5. Division 7 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
6. Division 8 Sections for storefront, windows and/or doors set in masonry construction.

C. Products installed, but not furnished, under this Section include the following:
1. Steel lintels and shelf angles for unit masonry, furnished under Division 5 Section "Metal Fabrications."

1.3 ALTERNATE: Refer to Division 1 Section "ALTERNATES" for listing of Bid alternates that may affect the work described herein

1.4 DEFINITIONS

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

1.5 PERFORMANCE REQUIREMENTS

A. Provide unit masonry that develops 1500 psi net-area compressive strength (f'_m) at 28 days.

1.6 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: For the following:

1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
2. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

D. Samples for Initial Selection: For the following:
1. Face brick, in the form of straps of five or more bricks indicating the full color range of each brick selection.
2. Colored mortar.
3. Weep holes/vents.

E. Samples for Verification: For each type and color of the following:
1. Face brick, in the form of straps of five or more bricks.
2. Pigmented and colored-aggregate mortar. Make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
3. Weep holes/vents.
4. Accessories embedded in masonry.

F. 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. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.

G. Qualification Data: For testing agency.

H. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:

1. Masonry units.

a. Include material test reports substantiating compliance with requirements.
b. For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.
c. For exposed brick, include material test report for efflorescence according to ASTM C 67.
d. For concrete masonry units used in structural masonry, include material certification that concrete masonry units conform to ASTM C 90.

2. Cementitious materials. Include brand, type, and name of manufacturer.
3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
4. Grout mixes. Include description of type and proportions of ingredients.
5. Reinforcing bars.
6. Joint reinforcement.
7. Anchors, ties, and metal accessories.

I. Material Test Reports: From a qualified testing agency indicating and interpreting test results of the following for compliance with requirements indicated:

1. Each type of masonry unit required.

a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
b. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.

2. Mortar complying with property requirements of ASTM C 270.
3. Grout mixes complying with compressive strength requirements of ASTM C 476. Include description of type and proportions of grout ingredients.

J. Mix Designs: For each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports, per ASTM C 780, for mortar mixes required to comply with property specification.
2. Include test reports, per ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

K. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1093 for testing indicated, as documented according to ASTM E 548.

B. 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, through one source and production run from a single manufacturer for each product required.

C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer and production run for each cementitious component and from one source or producer for each aggregate.

D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

E. Sample Panels: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects. Comply with requirements in Division 1 Section "Quality Requirements" for mockups. Locate mockup as directed by Architect with finish face to have southern exposure. Protect during construction and do not remove until authorized by Architect.
1. Build sample panels for each type and color of exposed unit masonry construction **(including Sound Absorptive CMU)** in sizes approximately 60 inches long by 48 inches high.
2. Sample panels to include, thru wall flashing and weeps.
3. Clean one-half of exposed faces of panels with masonry cleaner indicated.
4. Protect approved sample panels from the elements with weather-resistant membrane.
5. Approval of sample panels is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Architect in writing. Approval of sample panels or demonstration mock up does not constitute approval of deviations from the Contract Documents contained in sample panels unless such deviations are specifically approved by Architect in writing.

F. Demonstration Wall Mock Up: Provide 6’ wide by 2’ wide X 12’ high representing typical building exterior corner and window installation composed of all masonry types and colors, metal panel, parapet, flashing coping and other exterior wall components. Architect will provide sketch of final mockup configuration. Include structural backup (CMU and/or steel stud

framing) along with anchors. Also include expansion joint with backer rod & sealant installation.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.8 DELIVERY, STORAGE, AND HANDLING

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

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

1.9 PROJECT CONDITIONS

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

1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
2. Where 1 wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 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 ACI 530.1/ASCE 6/TMS 602.

1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.

E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

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. Products: Subject to compliance with requirements, provide one of the products specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
5. Basis-of-Design Product: The design for the product identified is based on the product names. The use of a trade name and/or suppliers name and address in the specifications is to indicate a possible source of the product and a standard of quality. Products of the same type from other sources shall not be excluded, provided they posses like physical and functional and aesthetic characteristics.

2.2 MASONRY UNITS, GENERAL

A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not uses units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 CONCRETE MASONRY UNITS (CMUs)

A. Shapes: Provide shapes indicated and as follows:

1. Provide special shapes for lintels, corners, 45 degree corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
2. Provide bullnose units for outside corners for, unless otherwise indicated.
3. Where soaps are indicated or required, provide custom (shop modified) bullnose units for soaps with outside corners and exposed terminations. Radius to match standard units.

B. Concrete Masonry Units: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 PSI.
2. Weight Classification: **Normal weight**, unless otherwise indicated.
3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.
4. Exposed Faces: Provide color and texture matching the range represented by Architect's sample.
5. At radius walls provide standard units except at corners and other locations where joints cannot accommodate produced by sawing concealed surfaces.

2.4 BRICK

A. General: Provide shapes indicated and as follows:

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

B. Face Brick: ASTM C 216, Grade SW, Type FBX.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi .
2. Initial Rate of Absorption: Less than 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested per ASTM C 67.
3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
4. Size (Actual Dimensions): Modular, 3 5/8” x 7 5/8” x 2 ¼”.

5. Color and Texture: As selected by Architect.

6. All face brick shall come from a single source. Each color brick including special shapes shall be from the same production run.

7. Contractor may provide brick from one of the following manufacturers subject to compliance with the stated performance criteria and approved color and finish samples.
8. Basis-of-Design Product:

    a. Glen-Gery Corporation, Rosedale

2.5 MORTAR AND GROUT MATERIALS

A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.

B. Hydrated Lime: ASTM C 207, Type S.

C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S or N as indicated.

D. Colored Cement Product: Packaged blend made from portland cement and lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.

1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's available colors.
2. Pigments shall not exceed 10 percent of portland cement by weight.
3. Available Products:

    a. Colored Portland Cement-Lime Mix:

        1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
        2) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
        3) Lafarge North America Inc.; Eaglebond.
        4) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
        5) Keystone Cement Company

E. Aggregate for Mortar: ASTM C 144.

1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

F. Aggregate for Grout: ASTM C 404.

G. Cold-Weather Admixture: Not permitted

H. Latex Additive:

1. Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.

2. 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. Bostik Findley Inc.
    b. Laticrete International, Inc.
    c. MAPEI Corp.
    d. TEC Specialty Construction Brands; H. B. Fuller Company.

I. Water: Potable.

2.6 REINFORCEMENT

A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).

B. Masonry Joint Reinforcement, General: ASTM A 951.

1. Interior Walls: Hot-dip galvanized, carbon steel.
2. Exterior Walls: Hot-dip galvanized, carbon steel.
3. Wire Size for Side Rods: W2.8 or 0.188-inch diameter.
4. Wire Size for Cross Rods: W2.8 or 0.188-inch diameter.
5. Wire Size for Veneer Ties: W2.8 or 0.188-inch diameter.
6. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
7. Provide in lengths of not less than 10 feet , with prefabricated corner and tee units.

C. Masonry Joint Reinforcement for Single-Wythe Masonry:

1. Either ladder or truss type with single pair of side rods.
2. Provide ladder type fro reinforced concrete masonry wall construction.

D. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Cavity Wall: Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate ties that extend into facing wythe. Ties have two hooks that engage eyes or slots in reinforcement and resist movement perpendicular to wall. Ties extend at least halfway through facing wythe but with at least ¾ inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

2.7 TIES AND ANCHORS

A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.

1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, hot-dip galvanized after fabrication to comply with ASTM A 153/A 153M.
3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.

C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units or hollow units laid with cells horizontal.
2. Where wythes do not align or are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches.
3. Wire: Fabricate from 3/16-inch- diameter, hot-dip galvanized steel wire.

D. Adjustable Anchors for Connecting to Structure: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire.
2. Tie Section for Steel Frame: Triangular-shaped wire tie, sized to extend within 1 inch of masonry face, made from 0.188-inch- diameter, hot-dip galvanized steel wire.

E. Partition Top anchors: 0.097-inch- thick metal plate with 3/8-inch- diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

F. Rigid Anchors: Fabricate from steel bars 1-1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins, unless otherwise indicated.

1. Corrosion Protection: Hot-dip galvanized to comply with ASTM A 153/A 153M.

G. Adjustable Masonry-Veneer Anchors

1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over rigid insulation and sheathing to metal studs, and as follows:

   a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch.

2. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.

a. Anchor Section: Sheet metal plate, 1-1/4 inches (32 mm) wide by 9 inches (225 mm) long, with screw holes top and bottom and with raised rib-stiffened strap, 5/8 inch (16 mm) wide by 5-1/2 inches (140 mm) long, stamped into center to provide a slot between strap and plate for inserting wire tie. **Provide with Pronged legs**
b. Screws to be type 410 stainless steel self drilling self taping #10-16 x 1 ½".
c. Fabricate sheet metal anchor sections and other sheet metal parts from 0.097-inch-thick, steel sheet, galvanized after fabrication
d. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.188-inch- diameter, hot-dip galvanized steel wire.
e. Products: Hohmann & Barnard, Inc.; "X-Seal" (formerly known as DW-10X) or approved equal. Size to suit application. (2" nominal typical).

2.8 MISCELLANEOUS ANCHORS

A. Dovetail Slots in Concrete: Furnish dovetail slots with filler strips, of slot size indicated, fabricated from 0.034-inch, galvanized steel sheet.

B. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

C. Postinstalled Anchors where required: Provide chemical or torque-controlled expansion anchors, with capability to sustain, without failure, a load equal to six times the load imposed when installed in solid or grouted unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.

1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (5 microns) for Class SC 1 service condition (mild).

2.9 EMBEDDED FLASHING MATERIALS

A. Flexible Flashing: Copper-Laminated Flashing, **5-oz./sq. ft.** copper sheet bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

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. Advanced Building Products Inc.; Copper Fabric Flashing.
b. Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
c. Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
d. Phoenix Building Products; Type FCC-Fabric Covered Copper.
e. Sandell Manufacturing Co., Inc.; Copper Fabric Flashing.
f. York Manufacturing, Inc.; Multi-Flash 500.

2. Provide Copper-Laminated Flashing at all thru wall flashing unless indicated otherwise.

3. Flashing Terminations: Provide at all inside and outside corners and transitions whether indicated or not. Provide end dams at terminations (except at loose lintels above doors and windows) and extend at least 3 inches into CMU masonry and out to exterior face of wall,. Extend flashing 4" beyond end of loose lintels and turn down edge so that water drains to adjacent cavity. At stud back seal flashing to sheathing.

B. Metal Flashing: Provide metal flashing, where flashing is exposed or indicated and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual and as follows:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 16 ga. thick. sawtooth keyed soft stainless.
2. Where required or indicated, fabricate through-wall flashing with snaplock receiver on exterior face where indicated to receive counterflashing.

C. Solder and Sealants for Sheet Metal Flashings:

1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
2. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.10 MISCELLANEOUS MASONRY ACCESSORIES

A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).

D. Weep/Vent Products: Mesh Weep/Vent: Free-draining mesh; made from UV resistant polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from manufacturer's available colors.

Products: Mortar Net USA, Ltd.; Mortar Net Weep Vents.

E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity. Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.

Products: Mortar Net USA, Ltd.; Mortar Net.

F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication. Provide units with either two loops or four loops as needed for number of bars indicated.

1. Available Products:

a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.
b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

2.11 MASONRY CLEANERS

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

1. Manufacturers:

a. Diedrich Technologies, Inc.
b. EaCo Chem, Inc.
c. ProSoCo, Inc.

2.12 MORTAR AND GROUT MIXES

A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.
2. Limit cementitious materials in mortar to portland cement, mortar cement, and lime.

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 C 270 and BIA Technical Notes 8A, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.

1. For masonry below grade or in contact with earth, use Type S.
2. For reinforced and non-reinforced CMU masonry, use Type S.
3. For exterior, above-grade, non-load-bearing walls, veneers and parapet walls; and for other applications where another type is not indicated, use Type N.

4. Provide Latex Additive at all following applications.
   a. Brick sill and cap conditions . .
   b. All structural or bearing brick.

D. Pigmented Mortar: Use following colored cement product for brick masonry. Do not add pigments to colored cement products.

1. Pigments shall not exceed 10 percent of portland cement by weight.

E. Grout for Unit Masonry: Comply with ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.

2.13 SOURCE QUALITY CONTROL

A. Owner will engage a qualified independent testing agency to perform source quality-control testing indicated below:

1. Payment for these services will be made by Owner

2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.

B. Clay Masonry Unit Test: For each type of unit furnished, per ASTM C 67.

C. Concrete Masonry Unit Test: For each type of unit furnished, per ASTM C 140.

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. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.

D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

G. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:

1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

H. **Provide painted stencils on all fire-rated and smoke partitions, with applicable Fire/Smoke rating. Locate each partition not to exceed 6'- 0" on center but not less than one per room per wall. Locate immediately above suspended ceilings or where indicated. Stencil label in red paint with numbers and letter minimum 4" high. Example "2 HR FIRE RATING"**

3.3 LAYING MASONRY WALLS

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

F. 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 concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.

I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above, unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.
2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c., unless otherwise indicated.
3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 7 Section "Fire-Resistive Joint Systems."

3.4 MORTAR BEDDING AND JOINTING

A. Lay hollow brick and concrete masonry units as follows:

1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.

3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Provide 100% Solid (no cores) masonry units for each course of masonry veneer bearing on steel relieving angles and lintels.

3.5 CAVITY WALLS

A. Bond wythes of cavity walls together using one of the following methods:

1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.

a. Where bed joints of both wythes align, use adjustable ladder-type reinforcement extending across both wythes.
b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement.
c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.

B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

1. Use wood blocking or insulation boards temporarily placed in cavities to collect mortar droppings as work progresses, remove strips clean off mortar, and peplace and continue.

3.6 MASONRY JOINT REINFORCEMENT

A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches (406 mm) o.c.
2. Space reinforcement not more than 8 inches (203 mm) o.c. in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings.

a. Reinforcement above is in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.7 ANCHORING MASONRY TO STRUCTURAL MEMBERS

A. Anchor masonry to structural members where masonry abuts or faces structural members to comply with the following:

1. Provide an open space not less than 1 inch (25 mm) in width between masonry and structural member, unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry to structural members 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 ANCHORING MASONRY VENEERS

A. Anchor masonry veneers to wall framing with masonry-veneer anchors to comply with the following requirements:

1. Fasten screw-attached anchors through rigid insulation and sheathing to wall framing backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
2. Embed tie sections connector sections and continuous wire in masonry joints. Provide not less than 1 1/2 inches of air space between back of masonry veneer and face of sheathing.
3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 16 inches o.c. horizontally with not less than 1 anchor for each 1.87 sq. ft. of wall area. Install additional anchors within 8 inches of openings and at intervals, not exceeding 12 inches, around perimeter.

3.9 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 using one of the following methods:

1. Install preformed control-joint gaskets designed to fit standard sash block.

C. Form expansion joints in brick made from clay or shale as follows:

1. Form open joint full depth of brick wythe and of width indicated, but not less than 1/2 inch for installation of sealant and backer rod specified in Division 7 Section "Joint Sealants."

D. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 7 Section "Joint Sealants," but not less than 3/8 inch (10 mm)

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.10 LINTELS

A. Install steel lintels where indicated.

B. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

A. General: Install embedded flashing and weep holes in masonry at **all** shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated

B. Install flashing as follows, unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry.
3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under building paper or building wrap, lapping at least 4 inches.
4. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 4 inches at ends and turn down.
5. Place flexible flashing flush with face of exposed wall after masonry wall.
6. Install flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall. Adhere flexible flashing to top of metal flashing termination where applicable.

C. Install reglets and nailers for flashing and other related construction where they are shown or required to be built into masonry. Do not saw cut reglet reveal without architects approval.

D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:

1. Use specified weep/vent products
2. Space weep holes 32 inches o.c., coordinate with notes on any wall section drawings unless otherwise indicated.

E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.

1. Install drainage mat above all flashing and at all weeps whether indicated on drawings or not)

3.12 REINFORCED UNIT MASONRY INSTALLATION

A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a special inspector and qualified independent testing and inspecting agency to perform special inspections in accordance with the applicable portions of Table 1704.5.1 (LEVEL 1 SPECIAL INSPECTION) of the 2006 International Building Code, and prepare test reports:

1. Payment for these services will be made by Owner.
2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
3. Place grout only after inspectors have verified compliance of grout spaces and grades, sizes, and locations of reinforcement.

B. Testing Frequency: One set of tests for each 5000 sq. ft. (465 sq. m) of wall area or portion thereof.

C. Mortar Test (Property Specification): For each mix provided, per ASTM C 780. Test mortar for compressive strength.

D. Grout Test (Compressive Strength): For each mix provided, per ASTM C 1019.

E. Prism Test: For each type of construction provided, per ASTM C 1314 at 7 days and at 28 days.

3.14 REPAIRING, POINTING, AND CLEANING

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

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.15 MASONRY WASTE DISPOSAL

A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION 042000

SECTION 053100 - STEEL DECK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Acoustical roof deck.

B. Related Sections include the following:

1. Section 017419 - Construction Waste Management.
2. Section 018113 – Sustainable Design Requirements.
3. Division 3 Section "Cast-in-Place Concrete" for concrete fill.
4. Division 5 Section "Structural Steel" for shop- and field-welded shear connectors.
5. Division 5 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
6. Division 9 painting Sections for repair painting of primed deck.

1.3 SUBMITTALS

A. Product Data: For each type of deck, accessory, and product indicated.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

D. Product Certificates: For each type of steel deck, signed by product manufacturer.

E. Welding certificates.

F. Field quality-control test and inspection reports.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following complies with requirements:

1. Power-actuated mechanical fasteners.
2. Acoustical roof deck.

H. Research/Evaluation Reports: For steel deck.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency qualified according to ASTM E 329 for testing indicated.

B. Welding: Qualify procedures and personnel according to AWS D1.3, "Structural Welding Code - Sheet Steel."

C. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

D. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so post-consumer recycled content plus one-half of pre-consumer recycled content is not less than 25 percent.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

1. Protect and ventilate acoustic roof deck with factory-installed insulation to maintain insulation free of moisture.

1.6 COORDINATION

A. Coordinate installation of sound-absorbing insulation strips in topside ribs of acoustical deck with roofing installation specified in Division 7 to ensure protection of insulation strips against damage from effects of weather and other causes.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Steel Deck:
   a. Epic Metals Corporation.
   b. New Millennium Building Systems, LLC.
   c. United Steel Deck, Inc.

2.2 ACOUSTICAL ROOF DECK

A. Acoustical Steel Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 30, and with the following:

   a. Color: White

2. Galvanized and Shop-Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's standard baked-on, rust-inhibitive primer.

   a. Color: Gray top surface with white underside.

3. Deck Profile: As indicated.
4. Profile Depth: As indicated.
5. Span Condition: Triple span or more.
6. Side Laps: Overlapped or interlocking seam at Contractor's option.
7. Acoustical Perforations: Deck units with manufacturer's standard perforated vertical webs.
8. Sound-Absorbing Insulation: Manufacturer's standard pre-molded roll or strip of glass or mineral fiber.

   a. Factory install sound-absorbing insulation into cells of cellular deck.

9. Acoustical Performance: Minimum NRC=0.90, tested according to ASTM C 423.

2.3 ACCESSORIES

A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.

B. Mechanical Fasteners: Corrosion-resistant, low-velocity, power-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.

C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 (4.8-mm) minimum diameter.

D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.

E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), not less than 0.0359-inch (0.91-mm) design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi (230 MPa), of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 30 for overhang and slab depth.

G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck, unless otherwise indicated.

H. Flat Sump Plate: Single-piece steel sheet, 0.0747 inch (1.90 mm) thick, of same material and finish as deck. For drains, cut holes in the field.

I. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION, GENERAL

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 30, manufacturer's written instructions, and requirements in this Section.

B. Locate deck bundles to prevent overloading of supporting members.

C. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.

D. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

E. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

F. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.

G. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

3.3 ROOF-DECK INSTALLATION

A. Fasten roof-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1-1/2 inches (38 mm) long, and as follows:

1. Weld Diameter: 5/8 inch (16 mm), nominal.
2. Weld Spacing: Minimum 36/5 weld pattern, unless noted otherwise on Drawings.

B. Side-Lap Fastening: Fasten side laps of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 36 inches (910 mm), and as follows:

1. Mechanically fasten with self-drilling, No. 10 (4.8-mm-) diameter or larger, carbon-steel screws.

C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches (38 mm), with end joints as follows:

1. End Joints: Lapped 2 inches (51 mm) minimum or butted at Contractor's option.

D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and mechanically fasten flanges to top of deck. Space mechanical fasteners not more than 12 inches (305 mm) apart with at least one fastener at each corner.

1. Install reinforcing channels or zees in ribs to span between supports and mechanically fasten.

E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof-deck panels, unless otherwise indicated.

F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform special inspections in accordance with the applicable portions of Table 1704.3 (Required Verification and Inspection of Steel Construction) of the 2006 International Building Code, and prepare test reports.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to Contractor and Architect.

D. Remove and replace work that does not comply with specified requirements.

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

3.5 REPAIRS AND PROTECTION

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

END OF SECTION 053100

SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Steel framing and supports for overhead doors.
2. Steel framing and supports for operable walls and/or accordion doors.
3. Shelf angles.
4. Loose bearing and leveling plates.
5. Steel weld plates and angles for casting into concrete not specified in other Sections.
6. Miscellaneous steel trim including steel angle corner guards sleeves and rough hardware.
7. Metal ladders including roof and elevator pit ladders.
8. Ladder safety cages.
9. Metal bollards.
10. Steel framing and supports for mechanical and electrical equipment.
11. Steel framing and supports for applications where framing and supports are not specified in other Sections.

B. Products furnished, but not installed, under this Section include the following:

1. Loose steel lintels.
2. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.

C. Related Sections include the following:

1. Division 3 Section " Cast-In-Place Concrete,
2. Division 4 Section "Unit Masonry Assemblies" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
3. Division 5 Section "Structural Steel."
4. Division 6 Section "Rough Carpentry and Miscellaneous Carpentry" for metal framing anchors.

1.3 PERFORMANCE REQUIREMENTS

A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

B. Thermal Movements: Provide exterior metal fabrications 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 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 (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Prefabricated and manufactured items.
2. Metal nosings and treads.
3. Paint products.
4. Grout.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113

C. 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.
2. Provide templates for anchors and bolts specified for installation under other Sections.
3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Welding certificates.

E. Qualification Data: For professional engineer registered in state of Maryland.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."
4. AWS D1.6, "Structural Welding Code--Stainless Steel."

1.6 PROJECT CONDITIONS

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

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

A. Coordinate installation of anchorages for metal fabrications. 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.

B. Coordinate installation of steel weld plates and angles for casting into concrete that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.

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. Products: Subject to compliance with requirements, provide one of the products specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.3 FERROUS METALS

A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.

C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.

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. Rolled-Stainless-Steel Floor Plate: ASTM A 793.

F. Steel Tubing: ASTM A 500, cold-formed steel tubing.

G. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

H. Slotted Channel Framing (Uni-strut): Cold-formed metal channels with continuous slot complying with MFMA-3.

1. Size of Channels: 1-5/8 by 1-5/8 inches (41 by 41 mm) As indicated.
2. Material: Galvanized steel complying with ASTM A 653/A 653M, commercial steel, Type B structural steel, Grade 33 (Grade 230), with G90 (Z275) coating; 0.108-inch (2.8-mm) 0.079-inch (2-mm) 0.064-inch (1.6-mm) nominal thickness.
3. Material: Steel complying with ASTM A 1008/A 1008M, commercial steel, Type B structural steel, Grade 33 (Grade 230); 0.0966-inch (2.5-mm) 0.0677-inch (1.7-mm) 0.0528-inch (1.35-mm) minimum thickness; unfinished coated with rust-inhibitive, baked-on, acrylic enamel hot-dip galvanized after fabrication.

I. Cast Iron: ASTM A 48/A 48M, Class 30, unless another class is indicated or required by structural loads.

2.4 NONFERROUS METALS

A. Aluminum Plate and Sheet: ASTM B 209 (ASTM B 209M), Alloy 6061-T6.

B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), Alloy 6063-T6.

C. Aluminum-Alloy Rolled Tread Plate: ASTM B 632/B 632M, Alloy 6061-T6.

D. Aluminum Castings: ASTM B 26/B 26M, Alloy 443.0-F.

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, Class Fe/Zn 5, at exterior walls. Provide stainless-steel fasteners for fastening aluminum. Select fasteners for type, grade, and class required.

B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.

C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1) 2 (A4).

D. Anchor Bolts: ASTM F 1554, Grade 36.

1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.

E. Eyebolts: ASTM A 489.

F. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).

G. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

H. Wood Screws: Flat head, ASME B18.6.1.

I. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).

J. Lock Washers: Helical, spring type, ASME B18.21.1 (ASME B18.21.2M).

K. 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.

L. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.

1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
2. Material for Anchors in Exterior Locations or treated lumber: Alloy Group 1 (A1) 2 (A4) stainless-steel bolts complying with ASTM F 593 (ASTM F 738M) and nuts complying with ASTM F 594 (ASTM F 836M).

2.6 MISCELLANEOUS MATERIALS

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

B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
   1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

C. Zinc-Rich Primer: Complying with SSPC-Paint 20 or SSPC-Paint 29 and compatible with topcoat. Use primer with a VOC content of 420 g/L (3.5 lb/gal.) or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

F. Nonshrink, Metallic Grout: Factory-packaged, ferrous-aggregate grout complying with ASTM C 1107, specifically recommended by manufacturer for heavy-duty loading applications.

G. 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.

H. Concrete Materials and Properties: Comply with requirements in Division 3 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of **3500** psi, unless otherwise indicated.

2.7 FABRICATION, GENERAL

A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Form exposed work true to line and level with accurate angles and surfaces and straight edges.

E. Weld corners and seams continuously to comply with the following:

   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
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.

F. 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.

G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

I. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

2.8 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 retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
1. Furnish inserts if units are installed after concrete is placed.

C. Fabricate supports for operable partitions and other suspended items from continuous steel beams of sizes indicated with attached bearing plates, anchors, and braces as indicated. Drill bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition Shop Drawings.

D. Fabricate steel girders for wood frame construction from continuous steel shapes of sizes indicated.

1. Provide bearing plates welded to beams where indicated.
2. Drill girders and plates for field-bolted connections where indicated.
3. Where wood nailers are attached to girders with bolts or lag screws, drill holes at 24 inches.

E. Fabricate steel pipe columns for supporting wood frame construction from steel pipe with steel baseplates and top plates as indicated. Drill baseplates and top plates for anchor and connection

bolts and weld to pipe with fillet welds all around. Make welds the same size as pipe wall thickness, unless otherwise indicated.

1. Unless otherwise indicated, fabricate from Schedule 40 steel pipe.
2. Unless otherwise indicated, provide 1/2-inch baseplates with four 5/8-inch anchor bolts and 1/4-inch top plates.

F. Galvanize miscellaneous framing and supports located on building exterior and where indicated

G. Prime miscellaneous interior framing and supports with zinc-rich primer unless otherwise indicated.

2.9 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. Weld adjoining members together to form a single unit where indicated.

B. Galvanize loose steel lintels located in exterior walls.

2.10 LOOSE BEARING AND LEVELING PLATES

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

B. Galvanize plates after fabrication.

C. Prime plates with zinc-rich primer.

2.11 STEEL WELD PLATES AND ANGLES

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.12 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. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

C. Galvanize all exterior miscellaneous steel trim, and interior miscellaneous steel trim, where indicated.

D. Prime interior miscellaneous steel trim, with zinc-rich primer, unless noted to be galvanized.

2.13 METAL LADDERS

A. General:

1. Comply with ANSI A14.3, unless otherwise indicated.
2. For elevator pit ladders, comply with ASME A17.1.
3. Space siderails as noted unless otherwise indicated.

    a. 24 inches apart at roof access ladders

4. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.

B. Steel Ladders:

1. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
2. Rungs: 3/4-inch- square steel bars.
3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
4. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
5. "Ladder up" Safety Posts: Provide at all roof and floor hatches
   Spring balanced safety post below hatch, manhole covers. Post shall have adjustable mounting brackets to fit ladder rung spacing up to 14" on center and clamp brackets to accommodate ladder rungs up to 1 ¾" in diameter. Tubular post shall be manufactured of high strength steel and shall lock automatically when fully extended. Controlled upward and downward movement of the safety post shall be provided by a stainless steel spring balancing mechanism. A release lever shall disengage the post to allow it to be retuned to its lowered position. Finish shall be manufacturer's standard.

2.14 LADDER SAFETY CAGES

A. General:

1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners, unless otherwise indicated.

B. Steel Ladder Safety Cages:

1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
3. Vertical Bars: 3/16-by-1-1/2-inch flat bars secured to each hoop.

4. Galvanize exterior ladder cages including fasteners.
5. Prime interior ladder cages, including fasteners, with zinc-rich primer.

2.15 METAL BOLLARDS

A. Fabricate metal bollards from Schedule 40 steel pipe unless otherwise indicated. Cap bollards with 1/4-inch- thick steel plate.

B. Fabricate bollards with 3/8-inch thick steel baseplates for bolting to concrete slab. Drill baseplates at all 4 corners for 3/4-inch anchor bolts. Where bollards are to be anchored to sloping concrete slabs, angle baseplates for plumb alignment of bollards.

2.16 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.

2.17 STEEL AND IRON FINISHES

A. Galvanizing: Hot-dip galvanize 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.

B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B) and Items Indicated to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
3. Ornamental stair, guardrail and associated components: SSPC-SP 6, "Commercial Blast Cleaning."
4. Where designated.

C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, 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.

1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

C. Field Welding: Comply with the following requirements:

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

D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.

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

3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

B. Anchor supports for operable partitions securely to and rigidly brace from building structure.

C. Provide separator sheet between all pressure treated wood blocking and miscellaneous framing, supports, metal deck, steel studs, copings, curbs, and other steel or aluminum components.

D. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.

1. Where grout space under bearing plates is indicated for fabrications and members supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.

3.3 INSTALLING BEARING AND LEVELING PLATES

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonshrink grout, nonmetallic grout unless otherwise indicated. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.4 INSTALLING METAL BOLLARDS

A. Anchor bollards to existing construction with expansion anchors anchor bolts through bolts. Provide four 3/4-inch bolts at each bollard, unless otherwise indicated.

1. Embed anchor bolts at least 4 inches in concrete.

B. Unless otherwise indicated, anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches (75 mm) above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured. Fill annular space around bollard solidly with nonshrink, nonmetallic grout; mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/8 inch toward bollard. .

C. Fill bollards solidly with concrete where no cap is indicated, mound top surface to shed water.

3.5 ADJUSTING AND CLEANING

A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

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

END OF SECTION 055000

SECTION 058100 - ARCHITECTURAL JOINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:
1. Architectural joint systems for building interiors.
2. Architectural joint systems for exterior walls.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for cast-in architectural-joint-system frames furnished, but not installed, in this Section.
2. Division 4 Section "Unit Masonry Assemblies" for masonry wall joint systems.
3. Division 7 Section "Roof Expansion Assemblies" for factory-fabricated roof joint systems.

1.3 DEFINITIONS

A. Maximum Joint Width: Widest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.

B. Minimum Joint Width: Narrowest linear gap a joint system tolerates and in which it performs its designed function without damaging its functional capabilities.

C. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (mm or inches) or a percentage (plus or minus) of nominal value of joint width.

D. Nominal Joint Width: The width of the linear opening specified in practice and in which the joint system is installed.

1.4 SUBMITTALS

A. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

B. Shop Drawings: Provide the following for each joint system specified:

1. Placement Drawings: Include line diagrams showing plans, elevations, sections, details, splices, block-out requirement, entire route of each joint system, and attachments to other work. Where joint systems change planes, provide isometric or clearly detailed drawing depicting how components interconnect.
2. Architectural Joint System Schedule: Prepared by or under the supervision of the supplier. Include the following information in tabular form:

    a. Manufacturer and model number for each joint system.
    b. Joint system location cross-referenced to Drawings.
    c. Nominal joint width.
    d. Movement capability.
    e. Classification as thermal or seismic.
    f. Materials, colors, and finishes.
    g. Product options.
    h. Fire-resistance ratings.

C. Samples for Verification: For each type of architectural joint system indicated.

1. Full width by 6 inches (150 mm) long, for each system required.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain interior architectural joint systems through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of architectural joint systems and are based on the specific systems indicated. Refer to Division 1 Section "Product Requirements."

1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

C. Accessibility Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines (ADAAG)" and ICC A117.1.

1.6 COORDINATION

A. Coordinate installation of exterior wall and soffit joint systems with roof expansion assemblies to ensure that wall transitions are watertight. Roof expansion assemblies are specified in Division 7.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063-T5 for extrusions; ASTM B 209 (ASTM B 209M), Alloy 6061-T6 for sheet and plate.

1. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: non-specular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.

B. Elastomeric Seals: Preformed elastomeric membranes or extrusions to be installed in metal frames.

C. Compression Seals: ASTM E 1612; preformed rectangular elastomeric extrusions having internal baffle system and designed to function under compression.

D. Strip Seals: ASTM E 1783; preformed elastomeric membrane or tubular extrusions having an internal baffle system and secured in or over a joint by a metal locking rail.

E. Cellular Foam Seals: Extruded, compressible foam designed to function under compression.

F. Elastomeric Concrete: Modified epoxy or polyurethane extended into a prepackaged aggregate blend, specifically designed for bonding to concrete substrates.

G. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.2 ARCHITECTURAL JOINT SYSTEMS, GENERAL

A. General: Provide architectural joint 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 joint changes direction or abuts other materials.
2. Include factory-fabricated closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint systems.

B. Design architectural joint systems for the following size and movement characteristics:

1. Nominal Joint Width: As scheduled
2. Movement Capability: Plus or minus 50 percent

2.3 ARCHITECTURAL JOINT SYSTEMS FOR BUILDING INTERIORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the products specified in individual subparagraphs below as basis-of-design products or a comparable product by one of the following:

1. Balco, Inc.
2. Construction Specialties, Inc.
3. MM Systems Corporation.
4. Watson Bowman Acme Corp.

B. Floor-to-Floor Joint Systems: (FEJ-1)
1. For 2 " joint: Balco model **6FC-1-2M**, Construction Specialties **ALR-2**, or equal.
2. Load Capacity: Standard Load Capacity:

C. Wall-to-Wall Joint Systems:
1. Masonry Walls (WEJ-1) for 2 " joint: Balco model **WD2**; Construction Specialties **SM-2N**, or equal. Provide similar model Balco model **WDC-2** corner applications.
2. Drywall partition (WEJ-2) for 2 " joint: Balco model **6GW-1-2**; Construction Specialties **AFW-200** or equal

D. Ceiling-to-Ceiling Joint Systems:
1. Lay-In Ceiling (CEJ-1) for 1 " joint: Balco model **C1W1**; Construction Specialties **SMC-1N**, or equal. Provide similar model Balco model **C1C1** or CS **SMC-1N** at corners
2. Drywall Ceiling (WEJ-2) for 1 " joint: Balco model **C1W1;** Construction Specialties **SMC-1N** or equal

E. Fire-Resistance assemblies: Provide fire-barrier backup assembly for joint system with a rating not less than that of adjacent construction as indicated on Life Safety Plan(s) All floors shall be minimum 1 Hour rating.

2.4 ARCHITECTURAL JOINT SYSTEMS FOR EXTERIOR WALL

A. Basis-of-Design Product: Subject to compliance with requirements, provide the products specified in individual subparagraphs below as basis-of-design products or a comparable product by one of the following:

1. Construction Specialties, Inc.VF-200
2. EMSEAL Joint Systems, Ltd. Colorseal
3. Architectural Art Mfg., Inc.
4. Balco, Inc.
5. MM Systems Corporation.
6. Nystrom, Inc.
7. R. J. Watson, Inc.

8. Schul International, Inc.
9. Tremco Sealant/Weatherproofing Division.

B. Architectural Joint Systems for Exterior Walls

1. Basis-of-Design Product: Construction Specialties, Inc.VF-200

2. Type: Preformed cellular foam.

a. Foam Material: Pre-manufactured factory-applied high-modulus silicone, acrylic impregnated expanding foam sealant and closed-cell (EVA) foam into a unified binary sealant system. Installed assembly to provide be watertight, thermal insulation, ± 50% movement capability, UV stability, and color coordination with substrates.

b. Color: As selected by Architect from manufacturer's full range

3. Fire-Resistance Rating: Match adjacent construction.

2.5 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.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and blockouts where architectural joint systems will be installed for installation tolerances and other conditions affecting performance of work. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to architectural joint system manufacturer's written instructions.

B. Repair concrete slabs and blockouts using manufacturer's recommended repair grout of compressive strength adequate for anticipated structural loadings.

C. Coordinate and furnish anchorages, setting drawings, and instructions for installing joint systems. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of joint systems.

D. Cast-In Frames: Coordinate and furnish frames to be cast into concrete. Provide oversized block-outs to be in-filled with concrete after joint installation.

3.3 INSTALLATION

A. Comply with manufacturer's written instructions for storing, handling, and installing architectural joint assemblies and materials unless more stringent requirements are indicated.

B. Coordinate installation of Fire-Resistance-Rated Assemblies with architectural joint assembly materials and associated work with so completed assemblies comply with assembly performance requirements. Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and field splices.

C. Metal Frames: Perform cutting, drilling, and fitting required to install joint systems.

1. Install in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Adjust for differences between actual structural gap and nominal design gap due to ambient temperature at time of installation. Notify Architect where discrepancies occur that will affect proper joint installation and performance.
3. Cut and fit ends to accommodate thermal expansion and contraction of metal without buckling of frames.
4. Locate in continuous contact with adjacent surfaces.
5. Standard-Duty Systems: Shim to level where required. Support underside of frames continuously to prevent vertical deflection when in service.
6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches (75 mm) from each end and not more than 24 inches (600 mm) o.c.

D. Seals in Metal Frames: Install elastomeric seals and membranes in frames to comply with manufacturer's written instructions. Install with minimum number of end joints.

1. Provide in continuous lengths for straight sections.
2. Seal transitions according to manufacturer's written instructions. Vulcanize or heat-weld field-spliced joints as recommended by manufacturer.
3. Installation: Mechanically lock seals into frames or adhere to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

E. Compression Seals: Apply adhesive or lubricant adhesive as recommended by manufacturer to both frame interfaces before installing compression seals.

F. Epoxy-Bonded Seals: Pressurize seal for time period and to pressure recommended by manufacturer. Do not over-pressurize.

G. Terminate exposed ends of joint assemblies with field- or factory-fabricated termination devices.

H. Infill floor block-outs with concrete and finish flush with adjacent surfaces so that finish slope does not exceed 1/8 inch per foot.

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 joints. Reinstall cover plates or seals prior to Substantial Completion of the Work.

END OF SECTION 058100

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Framing with dimension lumber.
2. Framing with engineered wood products, plywood sheathing.
3. Blocking for cants and nailers

B. Related Sections include the following:

1. Division 06 Section "Miscellaneous Carpentry."

1.3 DEFINITIONS

A. Exposed Framing: Framing not concealed by other construction.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.

C. Timber: Lumber of 5 inches nominal (114 mm actual) or greater in least dimension.

D. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. RIS: Redwood Inspection Service.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.4 SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-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 specified to be High-Temperature (HT) type, 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.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Fastener Patterns: Full-size templates for fasteners in exposed framing.

D. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

E. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:

1. Wood-preservative-treated wood.
2. Fire-retardant-treated wood.
3. Engineered wood products.
4. Power-driven fasteners.
5. Powder-actuated fasteners.

6. Expansion anchors.
7. Metal framing anchors.

1.5 QUALITY ASSURANCE

A. Source Limitations for Engineered Wood Products: Obtain each type of engineered wood product through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
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.

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

2. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or 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 cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).

1. Use Exterior type for exterior locations and where indicated.
2. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.
3. Use Interior Type A, unless otherwise indicated.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.

C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.

D. Application: Treat items indicated on Drawings, and the following:

1. Framing for raised platforms.
2. Concealed blocking.
3. Framing for non-load-bearing partitions.
4. Framing for non-load-bearing exterior walls.
5. Roof construction.
6. Plywood backing panels.

2.4 DIMENSION LUMBER FRAMING

A. Maximum Moisture Content: 19 percent.

B. Non-Load-Bearing Interior Partitions: No. 2 Stud.

C. Joists, Rafters, and Other Framing: No. 2 grade and any of the following species:

1. Hem-fir (north); NLGA.
2. Southern pine; SPIB.
3. Douglas fir-larch; WCLIB or WWPA.
4. Mixed southern pine; SPIB.
5. Spruce-pine-fir; NLGA.
6. Douglas fir-south; WWPA.
7. Hem-fir; WCLIB or WWPA.
8. Douglas fir-larch (north); NLGA.
9. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

2.5 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel or with epoxy or polyester coating over zinc plated steel

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

G. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group 1 (A1)

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).

2.6 METAL FRAMING ANCHORS

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:

C. Basis-of-Design Products: Subject to compliance with requirements, provide comparable products by one of the following:

1. Alpine Engineered Products, Inc.
2. Cleveland Steel Specialty Co.
3. Harlen Metal Products, Inc.
4. KC Metals Products, Inc.
5. Simpson Strong-Tie Co., Inc.
6. Southeastern Metals Manufacturing Co., Inc.
7. USP Structural Connectors.

D. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those of basis-of-design products. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

E. 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 where stainless steel is not indicated.

F. Stainless-Steel Sheet: ASTM A 666, Type 316.

1. Use for exterior locations where in contact with treated lumber and where indicated.

G. Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges at least 85 percent of joist depth.

1. Thickness: 0.062 inch (1.6 mm).

H. I-Joist Hangers: U-shaped joist hangers with 2-inch- (50-mm-) long seat and 1-1/4-inch- (32-mm-) wide nailing flanges full depth of joist. Nailing flanges provide lateral support at joist top chord.

1. Thickness: 0.062 inch (1.6 mm).

I. Top Flange Hangers: U-shaped joist hangers, full depth of joist, formed from metal strap with tabs bent to extend over and be fastened to supporting member.

1. Strap Width: 1-1/2 inches (38 mm).
2. Thickness: 0.062 inch (1.6 mm).

J. Bridging: Rigid, V-section, nailless type, 0.050 inch (1.3 mm) thick, length to suit joist size and spacing.

K. Rafter Tie-Downs: Bent strap tie for fastening rafters or roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to side of rafter or truss, face of top plates, and side of stud below.

L. Rafter Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening rafters or roof trusses to wall studs below, 2-1/4 inches (57 mm) wide by 0.062 inch (1.6 mm) thick. Tie fits over top of rafter or truss and fastens to both sides of rafter or truss, face of top plates, and side of stud below.

M. Hold-Downs: Brackets for bolting to wall studs and securing to foundation walls with anchor bolts or to other hold-downs with threaded rods and designed with first of two bolts placed seven bolt diameters from reinforced base.

1. Bolt Diameter: 5/8 inch (15.8 mm).
2. Width: 2-1/2 inches (64 mm).
3. Body Thickness: 0.108 inch (2.8 mm).
4. Base Reinforcement Thickness: 0.108 inch (2.8 mm).

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

D. Metal Framing Anchors: Install metal framing to comply with manufacturer's written instructions.

E. Do not splice structural members between supports, unless otherwise indicated.

F. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

G. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.

2. Use copper naphthenate for items not continuously protected from liquid water.

H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
3. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
4. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
5. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
6. Table R602.3 (1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
7. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One- and Two-Family Dwelling Code.

I. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

J. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.

1. Comply with approved fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.

2. Use finishing nails, unless otherwise indicated.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

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

END OF SECTION 061000

SECTION 061053 - MISCELLANEOUS CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements," "Construction Waste Managements" and "Commissioning Requirements," for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:
1. Window Stools
2. Painted standing and running trim
3. Interior frames and jambs (painted)
4. Shelving and support brackets
5. Interior wood blocking and nailers.
6. Blocking for cants, and nailers
7. Wood furring sleepers, and grounds.
8.

B. Blocking shall be provided, but not limited to, at the following locations
1. Casework and shelving.
2. Tackboards and marker boards
3. Wall mounted door hardware
4. Fire Extinguisher Cabinets
5. Toilet accessories
6. Wall mounted equipment
7. As noted on drawings

C. Related Sections include the following:
1. Division 6 Section "Rough Carpentry"
2. Division 6 Section "Interior Architectural Woodwork."

1.3 DEFINITIONS

A. Dimension Lumber: Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NHLA: National Hardwood Lumber Association.

3. NLGA: National Lumber Grades Authority.
4. SPIB: The Southern Pine Inspection Bureau.
5. WCLIB: West Coast Lumber Inspection Bureau.
6. WWPA: Western Wood Products Association.

1.4 QUALITY ASSURANCE

A. Fabricator/Installer: A firm which has successfully produced work similar to the quality specified and in the quantity shown for a period of not less than 5 years.

B. Reference Standards: Comply with the applicable provisions for grading and workmanship of the "Architectural Woodwork Quality Standards", Version 2.0 (2005), published by the Architectural Woodwork Institute (AWI) (herein referred to as Standards), except as otherwise specified.

C. Structural Performance: Design, manufacture and install handrails to resist a 200 pound concentrated force applied in any direction at any point and a uniform force of 50 pounds per linear foot applied in any direction without distortion or failure.

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS, GENERAL

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
3. Provide dressed lumber, S4S, unless otherwise indicated.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Pressure Process: AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

D. Application: Treat items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, and similar concealed members in contact with masonry or concrete.
3. Wood floor plates that are installed over concrete slabs-on-grade.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Comply with performance requirements in AWPA C20 (lumber) and AWPA C27 (plywood).

1. Use treatment that does not promote corrosion of metal fasteners.
2. Use Exterior type for exterior locations and where indicated.
3. Use Interior Type A, unless otherwise indicated.

B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings, and the following:
1. Concealed blocking.
2. Plywood backing panels.
3. Plywood Sheathing complying with C31 and C27.

2.4 MISCELLANEOUS LUMBER

A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.

B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.

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 2 Common grade; NLGA, WCLIB, or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir, Construction or 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.

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

E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

2.5 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

A. Quality Standard: Comply with AWI Section 300.

B. Grade: Custom.
1. 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.
2. Assemble casings in plant except where limitations of access to place of installation require field assembly.
3. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.

C. Wood Species: Any closed-grain hardwood..

2.6 Window Stools for opaque finish: Painted hardwood unless noted otherwise.

2.7 PLYWOOD BACKING PANELS

A. Telephone and Electrical Equipment Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated,.
1. Provide ½" thick, 48"x96" panel in each telephone, data, and electrical room or closet.

2.8 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

F. Lag Bolts: ASME B18.2.1.

G. Bolts: Steel bolts complying with ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

H. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, nuts and, where indicated, flat washers; ASTM F 593 (ASTM F 738M) for bolts and ASTM F 594 (ASTM F 836M) for nuts, Alloy Group **1 (A1)**

I. 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.

2.9 MISCELLANEOUS MATERIALS

A. Adhesives for Gluing Sleepers to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

B. Separator sheet: 15# Building felt or 15 mil “underslab” vapor barrier.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

B. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.

C. 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.

D. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

E. 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.

F. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.2 WOOD GROUND, SLEEPER, BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved. Secure all pressure treated lumber with stainless steel or epoxy coated anchorage.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

C. Provide separator sheet between all pressure treated wood blocking and metal deck, steel studs, copings, curbs, and other steel or aluminum components.

3.3 STOOLS

A. Scribe window stools to fit. Cope and return bullnose at sides and ends. Back prime prior to installation

B. Fasten to blocking with countersunk fasteners. Plug and finish flush prior to field painting.

3.4 PROTECTION

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

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

END OF SECTION 061053

SECTION 061600 – SHEATHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Wall sheathing.
2. Weather Barrier

B. Related Requirements:

1. Division 06 Section "Miscellaneous Carpentry" for plywood backing panels.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5516.
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.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 INFORMATIONAL SUBMITTALS

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

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

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Test-Response Characteristics: For assemblies with fire-resistance ratings, provide materials and construction identical to those of assemblies tested for fire resistance per ASTM E 119 by a testing and inspecting agency acceptable to authorities having jurisdiction.

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

2.2 WOOD PANEL PRODUCTS

A. Plywood: Either DOC PS 1 or DOC PS 2 unless otherwise indicated.

B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.

C. Factory mark panels to indicate compliance with applicable standard.

2.3 PRESERVATIVE-TREATED PLYWOOD

A. Preservative Treatment by Pressure Process: 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. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.

C. Application: Treat items indicated on Drawings and plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

2.4 FIRE-RETARDANT-TREATED PLYWOOD

A. General: Where fire-retardant-treated materials are 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 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 (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 plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Design Value Adjustment Factors: Treated lumber plywood shall be tested according ASTM D 5516 and design value adjustment factors shall be calculated according to ASTM D 6305. Span ratings after treatment shall be not less than span ratings specified. For roof sheathing and where high-temperature fire-retardant treatment is indicated, span ratings for temperatures up to 170 deg F (76 deg C) shall be not less than span ratings specified.

C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.

D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.

E. Application: Treat plywood indicated on Drawings, and the following:

1. Roof and wall sheathing within 48 inches (1220 mm) of fire party walls.
2. Roof sheathing.
3. Subflooring and underlayment for raised platforms.

2.5 WALL SHEATHING

A. Plywood Wall Sheathing: Exterior, Structural I sheathing.

1. Span Rating: Not less than 16/0.
2. Nominal Thickness: Not less than 1/2 inch (13 mm).

2.6 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.

1. For roof and wall sheathing, provide fasteners of Type 304 stainless steel.

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 Wood Structural Panels: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.

1. For wall and roof sheathing panels, provide screws with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours according to ASTM B 117.

2.7 SIDING

A. Fiber Cement Vertical Siding:

1. “Hardie Panel HZ5 Vertical Siding”, James Hardie Building Products Inc. or approved equivalent.

2. Color to be selected from Manufacturers standard.

3. Follow Manufacturers instructions for installation.

4. Size: 4’-0” x 10’-0”

2.8 Weather Barriers:

A. Weather Barrier Self-Adhesive Membrane:

1. Blue Skin Weather Barrier, Self-Adhesive Membrane, by Henry Company/Bakor, or approved equivalent.

2. Storage: Store on end, in original packaging. Protect from weather elements or store in an enclosed area not subject to heat over 40◦ C or under -10◦C.

3. Preparation: All surfaces must be clean of oil, dust, and excess mortar. For best adhesion results all surfaces to receive manufacturer's standard primer.

4. Application: Follow all manufacturer's recommendations for application and coordinate with sheathing type.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.

B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.

C. Securely attach to substrate by fastening as indicated, complying with the following:

1. NES NER-272 for power-driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in ICC's "International Building Code."

D. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.

E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.

F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.

G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

3.2 WOOD STRUCTURAL PANEL INSTALLATION

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

B. Fastening Methods: Fasten panels as indicated below:

1. Wall Sheathing:

a. Screw to framing.
b. Space panels 1/8 inch (3 mm) apart at edges and ends.

END OF SECTION 061600

SECTION 061753 - METAL-PLATE-CONNECTED WOOD TRUSSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Wood roof trusses.
2. Wood truss bracing.
3. Metal truss accessories.

B. Related Sections include the following:
1. Division 6 Section "Sheathing" for roof sheathing and subflooring.

1.3 DEFINITIONS

A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

B. TPI: Truss Plate Institute, Inc.

C. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA: Northeastern Lumber Manufacturers' Association.
2. NLGA: National Lumber Grades Authority.
3. SPIB: The Southern Pine Inspection Bureau.
4. WCLIB: West Coast Lumber Inspection Bureau.
5. WWPA: Western Wood Products Association.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide metal-plate-connected wood trusses capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.

1. Design Loads: As indicated.
2. Maximum Deflection Under Design Loads:

a. Roof Trusses: Vertical deflection of 1/240 of span under total loading conditions.

1.5 SUBMITTALS

A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Prepared by a qualified professional engineer licensed in the State of Maryland. Show fabrication and installation details for trusses.

1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
2. Indicate sizes, stress grades, and species of lumber.
3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
4. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
5. Show splice details and bearing details.
6. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. LEED Submittal:

1. Certificates for Credit MR 7: Chain-of-custody certificates certifying that wood used to produce metal-plate-connected wood trusses complies with forest certification requirements. Include evidence that mill is certified for chain of custody by an FSC-accredited certification body.

    a. Include statement indicating costs for each certified wood product.

E. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss fabricating firm.

F. Qualification Data: For metal-plate manufacturer, fabricator, and installer.

G. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use.

1.6 QUALITY ASSURANCE

A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.

1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program that complies with quality-control procedures in TPI 1 and that involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.

C. Source Limitations for Connector Plates: Obtain metal connector plates from a single manufacturer.

D. Comply with applicable requirements and recommendations of the following publications:

1. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
2. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
3. TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."

E. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

F. Forest Certification: Provide metal-plate-connected wood trusses produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and store trusses to comply with recommendations of TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."

1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
3. Provide for air circulation around stacks and under coverings.

B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

1.8 COORDINATION

A. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 - PRODUCTS

2.1 DIMENSION LUMBER

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. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
3. Provide dressed lumber, S4S.
4. Provide dry lumber with 15 percent maximum moisture content at time of dressing.

B. Grade and Species: For truss chord and web members, provide dimension lumber of any species, graded visually or mechanically, and capable of supporting required loads without exceeding allowable design values according to AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

C. Minimum Chord Size For Roof Trusses: 2 by 6 inches nominal (38 by 140 mm actual) for both top and bottom chords.

D. Permanent Bracing: Provide wood bracing members that comply with requirements for miscellaneous lumber in Division 6.

2.2 METAL CONNECTOR PLATES

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. Alpine Engineered Products, Inc.
2. CompuTrus, Inc.
3. Eagle Metal Products.

B. General: Fabricate connector plates to comply with TPI 1.

C. Hot-Dip Galvanized Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G60 (Z180) coating designation; and not less than 0.036 inch (0.9 mm) thick.

2.3 FASTENERS

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Power-Driven Fasteners: NES NER-272.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).

F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.

2.4 METAL TRUSS 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:

1. Simpson Strong-Tie Co., Inc.
2. Southeastern Metals Manufacturing Co., Inc.
3. USP Structural Connectors.

B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer that meet or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

C. 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 where stainless steel is not indicated.

D. Stainless-Steel Sheet: ASTM A 666, Type [**304**] [**316**].

1. Use for exterior locations and where indicated.

E. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick. Clip is fastened to truss through slotted holes to allow for truss deflection.

F. Roof Truss Bracing/Spacers: U-shaped channels, 1-1/2 inches (38 mm) wide by 1 inch (25 mm) deep by 0.040 inch (1.0 mm) thick, made to fit between 2 adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.

2.5 FABRICATION

A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.

C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.

1. Fabricate wood trusses within manufacturing tolerances in TPI 1.

D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install wood trusses only after supporting construction is in place and is braced and secured.

B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.

C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.

D. Install and brace trusses according to TPI recommendations and as indicated.

E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.

F. Space trusses as indicated; adjust and align trusses in location before permanently fastening.

G. Anchor trusses securely at bearing points; use metal truss tie-downs as applicable. Install fasteners through each fastener hole in truss accessories according to manufacturer's fastening schedules and written instructions.

H. Securely connect each truss ply required for forming built-up girder trusses.

1. Anchor trusses to girder trusses as indicated.

I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.

J. Install wood trusses within installation tolerances in TPI 1.

K. Do not cut or remove truss members.

L. Replace wood trusses that are damaged or do not meet requirements.

1. Do not alter trusses in field.

3.2 REPAIRS AND PROTECTION

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

B. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.

C. Protective Coating: Clean and prepare exposed surfaces of metal connector plates. Brush apply primer, when part of coating system, and one coat of protective coating.

1. Apply materials to provide minimum dry film thickness recommended by coating system manufacturer.

END OF SECTION 061753

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements," "Construction Waste Managements" and "Commissioning Requirements," for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Stained standing and running trim (including base , picture rail, door frames)
2. Flush wood paneling (stained).
3. Interior ornamental work.
4. Interior frames and jambs. (Stain finish)
5. Wood veneer cabinets
6. Plastic-laminate cabinets.
7. Custom display cases
8. Plastic-laminate countertops.
9. Solid-surfacing-material countertops.
10. Hardwood (solid and veneer) countertop and caps (stain finish).
11. Stainless steel countertop (see Div 11)
12. Closet rod and shelves
13. as indicated on drawings
14. Shop finishing of interior woodwork.

B. Related Sections include the following:

1. Division 6 Section "Miscellaneous Carpentry" for wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
2. Division 9 Section "Painting" for opaque finishes.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

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

B. Product Data: For panel products, high-pressure decorative laminate, solid-surfacing material, including cabinet hardware and accessories, and finishing materials and processes.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

D. 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, and other items installed in architectural woodwork.
4. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.

E. Samples for Initial Selection. Upon request provide following::

1. Shop-applied transparent finishes.
2. Shop-applied opaque finishes.
3. Plastic laminates.
4. PVC edge material.
5. Thermoset decorative panels.
6. Solid-surfacing materials.

F. Samples for Verification:

1. Submit minimum of (4) sets of each wood product. Provide samples which indicate the full range of anticipated color, grain, and figuring .
   a. Lumber with or for transparent finish, not less than 4 inches wide by 12 inches for each species and cut, finished on 1 side and 1 edge.
   b. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
   c. Veneer-faced panel products with or for transparent finish, 8 by 10 inches for each species and cut. Include at least one face-veneer seam and finish as specified.
   d. Thermoset decorative-panels, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with edge banding on 1 edge.
   e. Solid-surfacing materials, 6 inches square.

2. Submit 1 each of the following
   a. Sample drawer construction
   b. Miter joints for standing trim.
   c. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
3. Submit the following upon request
   a. Exposed cabinet hardware, drawer guides and other accessories.

G. Woodwork Quality Standard Compliance Certificates:

H. Qualification Data: For Installer fabricator.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project, has successfully produced work similar to the quality specified and in the quantity shown for a period of not less than 5 years, 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:
1. Fabricator of products
2. Certified participant in AWI's Quality Certification Program
3. 5 years experience

C. Quality Standard: Comply with the applicable provisions for construction, finishes, installation, workmanship and other requirements of the "Architectural Woodwork Quality Standards", Version 2.0 (2005), published by the Architectural Woodwork Institute (AWI) (herein referred to as Standards), except as otherwise specified.

1. Provide AWI Quality Certification Program certificates indicating that woodwork, including installation, complies with requirements of grades specified.

D. Structural Performance: Design, manufacture and install handrails to resist a 200 pound concentrated force applied in any direction at any point and a uniform force of 50 pounds per linear foot applied in any direction without distortion or failure.

E. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 25 and 55 percent during the remainder of the construction period.

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.
2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

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

B. Hardware Coordination: Distribute copies of approved hardware schedule specified in Division 8 Section "Door Hardware (Scheduled by Describing Products)" to fabricator of architectural woodwork; coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Wood Species and Cut for Transparent Finish: Maple hard select clear white premium (no heart wood).

C. Wood Species for Opaque Finish: Any closed-grain hardwood,
.

D. Wood Products: Comply with the following:
1. Hardboard: AHA A135.4.
2. Medium-Density Fiberboard: ANSI A208.2, Grade MD , made with binder containing no urea formaldehyde].
3. Particleboard: ANSI A208.1, Grade M-2 M-2-Exterior Glue.
4. Softwood Plywood: DOC PS 1
5. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.

E. Medium-Density Fiberboard: ANSI A208.2, Grade MD made with binder containing no urea formaldehyde.
1. Particleboard: ANSI A208.1, Grade M-2-Exterior Glue.
2. Softwood Plywood: DOC PS 1 Medium Density Overlay.

F. Window Stools. Opaque finish to be fabricated from moisture resistant MDF: Medex as manufactured by Medite Corporation A Division of Sierrapine Ltd. 2685 North Pacific Highway Medford OR USA 97501 (800) 676 3339.

G. Thermoset Decorative Panels (melamine): Particleboard or medium-density fiberboard finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.

1. Provide matching High-Pressure Decorative Laminate PVC banding complying with LMA EDG-1 on components with exposed or semiexposed edges.

H. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:

a. Pionite
b. Formica Corporation.
c. Nevamar Company, LLC; Decorative Products Div.

d. Wilsonart International; Div. of Premark International, Inc.
e. Others as scheduled.

3. Colors and Patterns: As indicated by manufacturer's designations or selected by architect from full range of available colors, patterns, and/or textures. Architect may select from a combination of any of the manufacturers listed. Provide metallic laminates where scheduled.

a. Abet Laminati, Inc.
b. Arborite; Division of ITW Canada, Inc.
c. Formica Corporation.
d. Lamin-Art, Inc.
e. Nevamar Company, LLC; Decorative Products Div.
f. Panolam Industries International Incorporated.
g. Westinghouse Electric Corp.; Specialty Products Div.
h. Wilsonart International; Div. of Premark International, Inc.

ANY Lab Grade P'LAM

I. Solid-Surfacing Material: Homogeneous solid sheets of filled plastic resin complying with ISSFA-2.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Avonite, Inc.
b. Corian
c. Formica Corporation.
d. Nevamar Company, LLC; Decorative Products Div.
e. Swan Corporation (The).
f. Wilsonart International; Div. of Premark International, Inc.

2. Colors and Patterns: As selected by Architect from manufacturer's full range].

J. Tempered Float Glass for Cabinet Doors and for Cabinet Shelves: ASTM C 1048, Kind FT, Condition A, Type I, Class 1 (clear), Quality-Q3, with exposed edges seamed before tempering, 6 mm thick, unless otherwise indicated.

K. Uncoated Monolithic Continuously Manufactured Acrylic Sheet (Plexiglas) : ASTM D 4802, Category B-1, Type UVF (UV filtering), Finish 1 (smooth or polished).
1. Products: CYRO Industries; Acrylite FF, Ineos Acrylics; Lucite CP. Or approved equal.
2. Nominal Thickness: 3/16 inch
3. Transparent Color: Transparent colorless

2.2 FIRE-RETARDANT-TREATED MATERIALS

1. 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.

2.3 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 8 Section "Door Hardware (Scheduled by Describing Products)."

B. Butt Hinges: 2-3/4-inch (70-mm), 5-knuckle steel hinges made from 0.095-inch- (2.4-mm-) thick metal, and as follows:

1. Semiconcealed Hinges for Flush Doors: BHMA A156.9, B01361.
2. Semiconcealed Hinges for Overlay Doors: BHMA A156.9, B01521.

C. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 170 degrees of opening, self-closing.

D. Wire Pulls: Back mounted, solid metal 4 inches long, 5/16 inch in diameter: Stanley #4483-½, or equal.

E. Curved Euro Style Wire Pulls: Back mounted, solid metal: 158 cm long X 30 cm projection. Finish: Chrome matt. MFGR: Hafele 177.31.436

F. Catches:
Magnetic catches, BHMA A156.9, B03141
Push-in magnetic catches, BHMA A156.9, B03131
Roller catches, BHMA A156.9, B03071
Ball friction catches, BHMA A156.9, B03013.

G. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081 (recessed mounted K&V 255 / 256 or equal. Finish: White

H. Drawer Slides: BHMA A156.9, B05091. (Full extension all metal ball bearing):

1. Standard Duty (Grade 1, Grade 2, and Grade 3): Side mounted[and extending under bottom edge of drawer]; [full-extension] [partial-extension] type; [zinc-plated steel] [epoxy-coated steel] with polymer rollers.
2. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; [full-extension] [full-overtravel-extension] type; zinc-plated steel ball-bearing slides.
3. Box Drawer Slides: Grade 1HD-100 LB; for drawers not more than 6 inches high and 24 inches wide.
4. File Drawer Slides: Grade 1HD-150; for drawers more than 6 inches high or 24 inches wide.
5. Pencil Drawer Slides: Grade 1- 50 LB; for drawers not more than 3 inches high and 24 inches wide.

6. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
7. Trash Bin Slides: Grade 1HD-200; for trash bins not more than 20 inches high and 16 inches wide.

I. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063.
1. K & V Assembly P992ZC or equal.

J. Aluminum Slides for Sliding Glass Doors: BHMA A156.9, B07063. Provide fixed and sliding glazed panels with extruded aluminum track similar to "*Florence Model Pass-Thru Assembly D1670* as manufactured by C.R. Laurence Co. (800) 421-6144 Furnish *Without Screen* Finish clear anodized.

K. Showcase Sliding Glass Doors: Aluminum Triple track for double and triple sliding and stacking glass doors,. Assembly model #610165 as manufactured by Stylmark Minneapolis MN 800-328-2495 All doors to have edge matching framing molding including side trim #110026, pulls #110028, locks, endcaps and other components. #

L. Perforated metal

M. Cabinet Locks: Provide at all drawers and doors in casework:
1. Door Locks: BHMA A156.11, E07121.
2. Drawer Locks: BHMA A156.11, E07041.
3. Key all locks in each room the same unless noted otherwise. Master key all cabinets locks except inner lock at Narcotics cabinets in Nurse's exam room.

N. Grommets for Cable Passage through Countertops: 2 7/8 inch OD, color to be selected, molded-plastic grommets and matching plastic caps with slot for wire passage.
1. As manufactured by Doug Mockett & Company, Inc
2. Model # A2340 as manufactured by TMI Systems Design Corp.
3. Case model

O. Speak-Thru: Stainless steel non-amplified voice transfer inset with matching screws for mounting in glazed panel. Provide 5-inch diameter similar to Model No. SST5 as manufactured by C.R. Laurence Co. (800) 421-6144

P. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Stainless Steel: BHMA 630.

Q. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.91

R. Counter Top and Work Top Support Brackets: Preformed heavy duty prefinished steel brackets TMI Systems Design Corp Model A7455 or approved equal. Color as selected by Architect. Spacing not to exceed 48 inches.

S. Tackable surface for the custom millwork. Unmounted, 1/4" burlap-backed cork with self-healing soil resistant, washable surface. ASTM E-84 (Fuel Contribution) - Class B. NFPA253 (Critical Radiant Flux) - Class II.
1. Basis of design: Claridge Cork Bulletin Board or equal.

2. Architect to select from full range of available colors.

T. Hang rods: K & V #660 Stainless steel rod with #734 flanges.

U. Casters: ball bearing as suitable for carpet or resilient flooring. Rated for anticipated loads.

V. Table Legs: Hafele 60 mm diameter with adjustable foot and concealed floor anchor. Finish: silver epoxy coating (RAL 9006). Finish height as indicated on drawings.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips
1. Semi exposed or surface mounted: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
2. Concealed in walls: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.5 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium 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. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:

1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members 3/4 Inch (19 mm) Thick or Less: 1/16 inch
2. Edges of Rails and Similar Members More Than 3/4 Inch (19 mm) Thick: 1/8 inch
3. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members and Rails: 1/16 inch

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be

removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. 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.

G. Install glass to comply with applicable requirements in Division 8 Section "Glazing" and in GANA's "Glazing Manual." For glass in wood frames, secure glass with removable stops.

2.6 INTERIOR STANDING AND RUNNING TRIM, , FRAMES AND JAMBS

A. Quality Standard: Comply with AWI Section 300.

B. FOR TRANSPARENT FINISH: :
1. Grade: Premium.
2. Wood Species and Cut
3. Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building, unless otherwise indicated.

C. Construction
1. 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.
2. Assemble casings in plant except where limitations of access to place of installation require field assembly.
3. Assemble moldings in plant to maximum extent possible. Miter corners in plant and prepare for field assembly with bolted fittings designed to pull connections together.
4. Scribe window stools to fit. Cope and return at sides and ends

2.7 FLUSH WOOD PANELING

A. Grade: Premium.

B. Wood Species and Cut
1. For Transparent Finish: : Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building, unless otherwise indicated.

2. Lumber Trim and Edges: At fabricator's option, trim and edges indicated as solid wood (except moldings) may be either lumber or veneered construction compatible with grain and color of veneered panels.

C. Matching of Adjacent Veneer Leaves: Book match.

D. Veneer Matching within Panel Face: Center-balance match.

E. Panel-Matching Method: Match fabricated panels within each separate area selectively reduced in width as indicated.

F. Attachment: Concealed zee-clips.

2.8 WOOD CABINETS FOR TRANSPARENT FINISH

A. Grade: Premium.

B. AWI Type of Cabinet Construction: Flush overlay.

C. Wood Species and Cut for Exposed Surfaces: Maple hard select clear white premium (no heart wood).

1. Grain Direction: Vertically for drawer fronts, doors, and fixed panels.
2. Matching of Veneer Leaves: Book match.
3. Veneer Matching within Panel Face: Running match.
4. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.

D. Semiexposed Surfaces: Provide surface materials indicated below:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.
2. Drawer Sides and Backs: Thermoset decorative panels].
3. Drawer Bottoms: Thermoset decorative panels.

2.9 PLASTIC-LAMINATE CABINETS

A. Grade: Premium.

B. AWI Type of Cabinet Construction: Flush overlay

C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:

1. Horizontal Surfaces Other Than Tops: Grade HGS (1.2 mm) .
2. Postformed Surfaces: Grade HGP.(1.0 mm)
3. Vertical Surfaces: Grade HGS .(1.2 mm).
4. Edges: PVC edge banding 1 mm thick, matching laminate in color, pattern, and finish].

D. Materials for Semiexposed Surfaces:

1. Surfaces Other Than Drawer Bodies: Thermoset decorative panels.

a. Edges of Plastic-Laminate Shelves: PVC edge banding 1 mm thick, matching laminate in color, pattern, and finish all 4 edges.

2. Drawer Sides and Backs: Thermoset decorative panels.
3. Drawer Bottoms: Thermoset decorative panels.

E. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL. Thermoset decorative panels.

F. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces to match Architect's sample.

G. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops. DO WE NEED???

2.10 PLASTIC-LAMINATE COUNTERTOPS

A. Grade: Premium

B. High-Pressure Decorative Laminate Grade: HGS except post formed vanities to be HGP.

C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces to match Architect's sample.

D. Backsplash: Provide 4" high back-splash and end-splash, top-mounted square butt joint.

E. Edge Treatment: Same as laminate cladding on horizontal surfaces except at tops without base cabinets or located in student areas provide PVC edge banding 3 mm thick. Color shall match laminate in color, pattern, and finish.

F. Core Material: Particleboard

G. Core Material at Sinks: exterior-grade plywood or formaldehyde free exterior grade MDF.

H. Backer Sheet: Provide plastic-laminate backer sheet, Grade BKL, on underside of countertop substrate.

2.11 SOLID-SURFACING-MATERIAL COUNTERTOPS

A. Grade: Premium

B. Solid-Surfacing-Material Thickness: [1/2 inch (13 mm)] [3/4 inch (19 mm)].

C. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material to Match Architect's sample

D. Fabricate tops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.

1. Fabricate tops with shop-applied edges of materials and configuration indicated.
2. Fabricate tops with [shop-applied backsplashes] [loose backsplashes for field application].

E. Install integral sink bowls in countertops in shop.

F. Shop drill holes in countertops for plumbing fittings and other accessories.

2.12 CLOSET AND UTILITY SHELVING

A. Open, wall hung shelving, to be Thermoset decorative overlay on top and bottom of shelves, with 1 mil PVC tape in matching color on all four edges, except where hardwood edges are indicated.
   1. AWI Grade: Custom.
   2. Provide reinforced edges or 1 inch thick shelves where spans between supports exceed 36 inches

B. Hardware shall be heavy duty, metal brackets sized to accommodate shelf depth; BHMA A156.9, B04071. Standards to be slotted metal, vertical bracket supports, BHMA A156.9, B04013. Color White Space 2'-8" O.C. unless otherwise noted

2.13 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation. Refer to Division 9 painting Sections for finishing opaque-finished architectural woodwork.

C. Shop Priming: Shop apply the prime coat including backpriming, if any, for items specified to be field finished. Refer to Division 9 painting Sections for material and application requirements.

D. 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.

E. Transparent Finish:

   1. Grade: Premium
   2. AWI Finish System: Conversion varnish.
   3. Staining: Match Architect's sample.
   4. Provide finish engineered to achieve Class A flame spread rating where indicated.

5. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
6. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
7. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.

    a. Apply wash-coat sealer after staining and before filling.

8. Sheen: [Flat, 15-30] [Satin, 31-45] [Semigloss, 46-60] [Gloss, 61-100] 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 (3 mm in 2400 mm).

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

E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

F. Provide rigid, secure installation. 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 at semi-concealed locations] for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
2. Install wall railings on indicated metal brackets securely fastened to wall framing.
3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).

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.

I. Stairs: Securely anchor carriages to supporting substrates. Install stairs with treads and risers no more than 1/8 inch (3 mm) from indicated position.

J. Railings:

1. General: Install rails with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) variation from a straight line.
2. Stair Rails: Glue and dowel or pin balusters to treads and railings, and railings to newel posts.
3. Wall Rails: Support rails on indicated metal brackets securely fastened to wall framing.

K. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Secure cabinets permanently to floor and wall construction using anchors spaced at maximum of 30" o.c. minimum of two for each unit
4. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with finish No. 10 wafer-head screws or oval head screws with collar type washers.sized for minimum 1-inch (25-mm) penetration into wood framing, blocking, or hanging strips. All fasteners inside cabinets semi-exposed to view shall align horizontally and vertrically

L. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

2. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
3. Secure backsplashes to walls with adhesive.
4. Calk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."

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

N. Refer to Division 9 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 064023

SECTION 071700 - BENTONITE WATERPROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes sheet composite HDPE/bentonite membrane waterproofing.at following locations:

1. All occupied or mechanical spaces below grade.
2. Where indicated.

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants" for elastomeric sealants.

1.3 PERFORMANCE REQUIREMENTS

A. Provide waterproofing that prevents the passage of water according to the following criteria:

1. Permeability: 5 by 10^{-10} cm/sec. according to ASTM D 5084.
2. Elongation: 300 percent according to ASTM D 4632.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include product specifications and manufacturer's written installation instructions.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for

LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show installation details for interface with other work.

D. Samples: For each of the following products, in sizes indicated:

1. Waterproofing: 6 inches square.
2. Flexible Flashing Membrane: 6 inches square.
3. Protection Board: 6 inches square.

E. Material Certificates: For each type of bentonite waterproofing, signed by manufacturers.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain bentonite waterproofing system through one source from a single manufacturer. Obtain accessory products used with bentonite waterproofing from sources acceptable to bentonite waterproofing manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site in manufacturer's original unopened and undamaged containers.

B. Store materials in a dry, well-ventilated space.

C. Remove and replace bentonite materials that have been prematurely exposed to moisture.

1.7 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit bentonite waterproofing to be installed according to manufacturers' written instructions and warranty requirements.

1. Do not apply waterproofing materials to surfaces where ice or frost is visible. Do not apply bentonite waterproofing materials in areas with standing water.
2. Placing of bentonite clay products in panel or composite form on damp surfaces is allowed if approved in writing by manufacturer.

1.8 WARRANTY

A. Special Warranty: Manufacturer's unlimited warrantee standard form in which manufacturer and Installer agrees to repair or replace components of bentonite waterproofing system that fail in materials or workmanship within specified warranty period. **Limited or prorated warranted will not be accepted**

1. Failures include, but are not limited to, the following:

a. Water penetrating the building or structure resulting from substrate cracking of up to 1/8 inch.
b. Deteriorated or displaced waterproofing materials.

2. Warranty Period: Five [5] years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products listed in other Part 2 articles.

B. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Granular Bentonite: Sodium bentonite clay containing a minimum of 90 percent montmorillonite (hydrated aluminum silicate), with a minimum of 90 percent passing a No. 20 sieve.

B. Bentonite Mastic: Trowelable consistency, bentonite compound, specifically formulated for application at joints and penetrations.

C. Granular Bentonite Tubes: Manufacturer's standard 2-inch- diameter, water-soluble tube containing approximately 1.5 lb/ft. of bentonite; hermetically sealed; designed specifically for placing on wall footings at line of joint with exterior base of wall.

D. Preformed Waterstop: Flexible strip of bentonite waterproofing compound in cartridge or coil form; designed specifically for vertical and horizontal joints in concrete construction.

E. Bentonite Grout: High-solids bentonite fluid mixture formulated to be injected to stop leaks in existing below-grade structures.

2.3 COMPOSITE HDPE/BENTONITE MEMBRANE

A. Vertical Applications: Composite HDPE/Bentonite Membrane: Minimum 90-mil- thick membrane consisting of a 20-mil- thick, HDPE geomembrane liner bonded to a layer of bentonite clay granules 78 mils thick, and with a 1.5-mil- thick siliconized release liner.

1. Available Products:

a. CETCO; Swelltite.
b. Tremco Sealant/Waterproofing Division, an RPM company; Parastick-N-Dry.

B. Horizontal Underslab and Elevator Pit Walls: Composite Gastight HDPE/Bentonite Membrane: Minimum 150-mil thick membrane consisting of, HDPE geomembrane liner bonded to a layer of bentonite clay granules.

1. Products:

a. Tremco Sealant/Waterproofing Division, an RPM company; Paraseal GM.

b. CETCO; Volclay BPA Type-T – SP.

2.4 INSTALLATION ACCESSORIES

A. Protection Board: Provide products recommended in writing by waterproofing manufacturer to suit Project. Available types include the following:

1. Semirigid board with mineral-reinforced asphaltic core laminated between an asphalt-saturated felt liner on one side and a weather-coated, glass-mat liner covered with a bond-breaking film on the other.

a. Thickness: 1/8 inch.

B. Termination Bar: Extruded-aluminum or formed-stainless-steel bars with upper flange to receive sealant.

C. Plastic Protection Sheets: Polyethylene sheeting complying with ASTM D 4397; thickness as recommended in writing by waterproofing manufacturer to suit application but at least 6 mils thick.

D. Fasteners: Case-hardened nails or hardened-steel, powder-actuated fasteners. Depending on manufacturer's written requirements, provide 1/2- or 1-inch-diameter washers under fastener heads.

E. Sealants: As recommended in writing by waterproofing manufacturer. Comply with requirements specified in Division 7 Section "Joint Sealants."

F. Tapes: As recommended in writing by waterproofing manufacturer for joints between sheets or panels.

G. Adhesive: Water-based adhesive used to secure membrane to both vertical and horizontal surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrate preparations affecting performance of bentonite waterproofing.

1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of bentonite waterproofing.
2. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Verify that substrate is complete and that all work that will penetrate waterproofing is complete and rigidly installed. Verify locations of waterproofing termination.

3.2 PREPARATION

A. Coordinate work in the vicinity of waterproofing to ensure proper conditions for installing the waterproofing system and to prevent damage to waterproofing after installation.

B. Formed Concrete Surfaces: Remove fins and projections. Fill voids, rock pockets, form-tie holes, and other defects with bentonite mastic or cementitious patching material according to manufacturer's written instructions.

C. Horizontal Concrete Surfaces: Remove debris, standing water, oily substances, mud, and similar substances that could impair the bonding ability of concrete or the effectiveness of waterproofing. Fill voids, cracks greater than 1/8 inch, honeycomb areas, and other defects with bentonite mastic or cementitious patching material according to manufacturer's written instructions.

D. Excavation Support and Protection or Stable Excavation: If water is seeping, use plastic sheets or other suitable means to prevent wetting the bentonite waterproofing. Fill minor gaps and spaces 1/8 inch wide or wider with wood, metal, concrete, or other appropriate filling material. Cover or fill large voids and crevices with cement mortar according to manufacturer's written instructions.

3.3 INSTALLATION, GENERAL

A. Install waterproofing and accessories according to manufacturer's written instructions, standard details, and recommended practices.

1. Apply linear joint-sealing tubes, bentonite mastic, or both at changes of plane, construction joints in substrate, projections, and penetrations.
2. Apply granular bentonite around penetrations in horizontal surfaces according to manufacturer's written instructions.

B. Static Construction Joints: Protect construction joints with bentonite preformed waterstop flexible strips. Either place concrete directly over flexible strips or press strips into preformed cavities. Comply with manufacturers written instructions where joint waterproofing is not otherwise indicated.

C. Apply granular bentonite continuously at base of wall waterproofing (on footing, against wall) according to manufacturer's written instructions.

D. Protect waterproofing from damage and wetting before and during subsequent construction operations. Repair punctures, tears, and cuts according to manufacturer's written instructions.

E. Install Termination bars at upper termination of vertical membrane waterproofing.

F. Apply sealants to comply with requirements of manufacturer's written instructions.

3.4 COMPOSITE HDPE/BENTONITE MEMBRANE INSTALLATION

A. General: Install a continuous layer of waterproofing membrane with ends and edges lapped a minimum of 3 inches. Stagger end joints between membranes. Fasten seams by stapling to adjacent sheet or nailing to substrate.

B. Below Structural Slabs-on-Grade and Cast in Place Wall: Apply waterproofing membrane with HDPE side down and staple ends and edges.

1. Install under footings, grade beams, and pile caps; or continue waterproofing through key joints between footings and foundation walls, and extend a minimum of 8 inches up or beyond perimeter slab forms.
2. Protect waterproofing from damage caused by chairs with sharp edges.

C. Concrete Walls: Apply mastic around penetrations and form continuous 2-inch cant at intersection of footings and walls with mastic.

1. Starting at lowest point, install a layer of waterproofing membrane horizontally, extending a minimum of 6 inches onto the footing. Lap membrane ends and edges a minimum of 3 inches.
2. Secure membrane to wall with adhesive or washer-headed fasteners and terminate membrane at grade with tape, according to manufacturer's written instructions.
3. Termination at Grade: Extend waterproofing membrane to within 2 inches of finish grade, unless otherwise indicated. Secure top edge with termination bar. Apply sealant to top edge of termination bar.

D. Install protection over vertical bentonite waterproofing as soon as possible to prevent damage form construction activities and backfiulling operations.

END OF SECTION 071700

SECTION 072100 - BUILDING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. “Perimeter insulation” under slabs-on-grade and foundation walls.
2. Rigid Insulation sandwiched between concrete slab
3. Concealed building insulation.
4. Vapor retarders

B. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for insulation installed in cavity walls and masonry cells.
2. Division 7 Section "EPDM Roofing” for insulations under membrane roofing.
3. Division 7 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.
4. Division 9 Sections "Gypsum Board Assemblies" for installation of sound attenuation blankets in interior partitions.

1.3 DEFINITIONS

A. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.4 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of

postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Samples for Verification: Upon request provide full-size units for each type of exposed insulation indicated.

D. Product Test Reports: Upon request provide based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.

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

1. Surface-Burning Characteristics: ASTM E 84.
2. Fire-Resistance Ratings: ASTM E 119.
3. Combustion Characteristics: ASTM E 136.

1.6 DELIVERY, STORAGE, AND HANDLING

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

B. Protect plastic insulation as follows:

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

PART 2 - PRODUCTS

2.1 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 FOAM-PLASTIC BOARD INSULATION

A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and density indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively:

1. Available Manufacturers:

a. DiversiFoam Products.
b. Dow Chemical Company.
c. Owens Corning.
d. Pactiv Building Products Division.

2. 2” Thickness Type IV, 1.60 lb/cu. ft., unless otherwise indicated.
3. Type VII, 2.20 lb/cu. ft. where sandwiched between two concrete slab (40 psi compressive strength).

2.3 CELLULOSE INSULATION

A. Manufacturer:

1. Nu-Wool company Inc., 2472 Port Sheldon St., Jenison, Michigan, 49428 or approved equivalent. Meeting the following requirements.

B. Product:

1. Nu-Wool Premium Cellulose Insulation “WallSeal”, open wall cavity sprayed insulation.

2. Material Description:

a. Manufactured from recycled newspapers.
b. Post-Consumer Recycled Content 85 percent minimum.
c. Fibers: Treated with boric acid and sodium polyborate additives to create permanent flame resistance

d. Fungicide Additive

1) EPA registered
2) Makes insulation resistant to mold growth.

e. Additives

1) Non-toxic
2) Non-corrosive
3) Doe not irritate normal skin
4) Does not give off order during or after installation
5) Does not attract vermin or insects
6) Does not adversely affect other building materials.

3. Compliance

a. UL classified R-8078
b. CPSC standard 16 CFR Parts 1209 and 1404
c. ASTM C 739
d. ASTM E 119: Firewalls U382, U369a, U369b, U360
e. ES Report ESR-2217:

4. Test Results:

a. Settled Density

1) Maximum density after long-term settling of dry installation: 1.6 lbs per cu ft.

b. Thermal Resistance

1) Average thermal resistance (R-value) per inch 3.8.

c. Flammability Characteristics:

1) Critical Radiant Flux: 0.12 W/cm@ minimum
2) Smoldering Combustion: No evidence of flaming and weight loss of 15.0 percent maximum

d. Moisture Vapor Sorption:

1) Moisture Gain in Insulation: 15 percent maximum by weight.

e. Environmental Characteristics:

1) When in contact with steel, copper, aluminum, or galvanized materials: Non-corrosive
2) Does not support fungal growth

f. Surface Burning Characteristics, ASTM E 84 and UL 723: Nu-Wool Premium Cellulose Insulation.

1) Flame Spread Index: 15
2) Smoke Developed Index: 5

2.4 AUXILIARY INSULATING MATERIALS

A. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates indicated without damaging insulation and substrates.

2.5 INSULATION FASTENERS

A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of thickness indicated securely in position indicated with self-locking washer in place; and complying with the following requirements:

1. Available Products:

a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
b. Eckel Industries of Canada; Stic-Klip Type N Fasteners.
c. Gemco; Spindle Type.

A. Mechanical Anchors (stick pins) : Perforated plate, 2 inches square, welded to projecting pin, with self-locking washer, complying with the following requirements:
1. Plate: Zinc-plated steel, 0.106 inch thick.
2. Pin: Copper-coated low carbon steel, fully annealed, 0.106 inches in diameter, length to suit depth of insulation indicated and, with washer in place, to hold insulation tightly to substrate behind insulation.
3. Self-Locking Washer: Mild steel, 0.016 inch thick, size as required to hold insulation securely. After installation, remove surplus length and protect ends with capped self-locking washers.
4. Protective Cap: metal or plastic cap to have self-locking washers incorporating a spring steel insert to ensure permanent retention of cap.
5. Adhesive: Recommended by Anchor Manufacturer for the substrate.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements of Sections in which substrates and related work are specified and for other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 INSTALLATION, GENERAL

A. Comply with insulation manufacturer's written instructions applicable to products and application indicated.

B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed at any time to ice, rain, and snow.

C. Extend insulation in thickness indicated 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. Water-Piping Coordination: If water piping is located within insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

E. For preformed insulating units, 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.

3.4 INSTALLATION OF PERIMETER AND UNDER-SLAB INSULATION

A. On vertical surfaces, set insulation units in adhesive applied according to manufacturer's written instructions. Use adhesive recommended by insulation manufacturer.

1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) below exterior grade line.

B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.

C. Protect below-grade insulation on vertical surfaces from damage during backfilling by applying protection course with joints butted. Set in adhesive according to insulation manufacturer's written instructions.

3.5 INSTALLATION OF GENERAL BUILDING INSULATION

A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

3.6 PROTECTION

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

END OF SECTION 072100

SECTION 074213 - METAL WALL PANELS AND SOFFITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:
1. Factory-formed and field-assembled, exposed-fastener, lap-seam metal wall panels. Concealed-fastener, lap-seam metal wall panels (Metal Panel Type 3)
2. Metal soffit panels.

B. Related Sections include the following:

1. Division 5 Section "Cold-Formed Metal Framing" for secondary support framing supporting metal wall panels.
2. Division 7 Section "Sheet Metal Roofing" for standing seam metal roofing.
3. Division 7 Section "Sheet Metal Flashing and Trim" for fasciae, copings, flashings and other sheet metal work not part of metal wall panel assemblies.
4. Division 7 Section "Joint Sealants" for field-applied sealants not otherwise specified in this Section.

1.3 DEFINITIONS

A. Steel Sheet Thickness: Minimum thickness of base metal without metallic coatings or painted finishes.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide metal wall panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.

B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. (0.3 L/s per sq. m) of wall area when tested according to ASTM E 283 at a static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

C. Water Penetration: No water penetration when tested according to ASTM E 331 at a minimum differential pressure of 20 percent of inward-acting, wind-load design pressure of not less than 6.24 lbf/sq. ft. (300 Pa) and not more than 12 lbf/sq. ft. (575 Pa).

D. Water Absorption: Maximum 1.0 percent absorption rate by volume when tested according to ASTM C 209.

E. Structural Performance: Provide metal wall panel assemblies capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.

F. Thermal Movements: Provide metal wall panel assemblies 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 (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

G. Thermal Movements for Metal-Faced Composite Wall Panels: Provide composite wall panel assemblies that allow for noiseless thermal movements resulting from the following range in ambient temperatures and that prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects:

1. Ambient Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

H. Thermal Performance: Provide insulated metal wall panel assemblies with thermal-resistance value (R-value) indicated when tested according to ASTM C 236 or ASTM C 518.

1.5 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal wall panel and accessory.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show fabrication and installation layouts of metal wall panels; details of edge conditions, joints, panel profiles, corners, anchorages, attachment system, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.

1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:10):

a. Flashing and trim.

2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.

1. Metal Wall Panels: 12 inches (300 mm) long by actual panel width. Include fasteners, closures, and other metal wall panel accessories.

a. Include four-way joint for composite panels.

2. Trim and Closures: 12 inches (300 mm) long. Include fasteners and other exposed accessories.

E. Product test reports.

F. Maintenance data.

G. Warranties: Samples of special warranties.

1.6 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution.

1. Demonstration Wall Mock Up: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation. Furnish and install components described in this section as necessary for completion of building exterior corner and window installation as described in Section 4810 - UNIT MASONRY ASSEMBLIES. Mock Up to be 6’ wide by 2’ wide X 12’ high representing typical building exterior corner and window installation composed of all masonry types and colors, metal panel, parapet, flashing coping and other exterior wall components. Architect will provide sketch of final mockup configuration.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver components, sheets, metal wall panels, and other manufactured items so as not to be damaged or deformed. Package metal wall panels for protection during transportation and handling.

B. Unload, store, and erect metal wall panels in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack metal wall panels horizontally on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal wall panels to ensure dryness, with positive slope for drainage of water. Do not store metal wall panels in contact with other materials that might cause staining, denting, or other surface damage.

D. Protect strippable protective covering on metal wall panels from exposure to sunlight and high humidity, except to extent necessary for period of metal wall panel installation.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal wall panels to be performed according to manufacturers' written instructions and warranty requirements.

B. Field Measurements: Verify locations of structural members and wall opening dimensions by field measurements before metal wall panel fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish framing and opening dimensions and proceed with fabricating metal wall panels without field measurements, or allow for field trimming of panels. Coordinate wall construction to ensure that actual building dimensions, locations of structural members, and openings correspond to established dimensions.

1.9 COORDINATION

A. Coordinate metal wall panel assemblies with windows, masonry, susbstrates, flashing, trim, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Period: Five 5 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 wall panels that show evidence of deterioration of factory-applied finishes within specified warranty period.

1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

a. Color fading more than 5 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. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:

1. Basis-of-Design Product: The design for the product identified is based on the product named. The use of a trade name and/or suppliers name and address in the specifications is to indicate a possible source of the product and a standard of quality. Products of the same type from other sources shall not be excluded, provided they possess like physical and functional and aesthetic characteristics.

2.2 PANEL MATERIALS

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
2. Surface: Smooth, flat, unless otherwise noted.
3. Exposed Finishes: Apply the following coil coating, as specified or indicated on Drawings.
   a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

      1) Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil (0.038 mm); complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:

         a) Humidity Resistance: 1000 2000 hours.
         b) Salt-Spray Resistance: 1000 2000 hours.

4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

2.3 MISCELLANEOUS METAL FRAMING

A. Miscellaneous Metal Framing, General: ASTM C 645, cold-formed metallic-coated steel sheet, ASTM A 653/A 653M, G40 (Z120) hot-dip galvanized or coating with equivalent corrosion resistance unless otherwise indicated.

B. Subgirts: Manufacturer's standard C- or Z-shaped sections, 0.064-inch (1.63-mm) nominal thickness.

C. Zee Clips: 0.079-inch (2.01-mm) nominal thickness.

D. Base or Sill Angles Channels: 0.079-inch (2.01-mm) nominal thickness.

E. Hat-Shaped, Rigid Furring Channels:

1. Nominal Thickness: As required to meet performance requirements.
2. Depth: As indicated.

F. Cold-Rolled Furring Channels: Minimum 1/2-inch- (13-mm-) wide flange.

1. Nominal Thickness: As required to meet performance requirements 0.064 inch (1.63 mm).
2. Depth: As indicated.
3. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with 0.040-inch (1.02-mm) nominal thickness.
4. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.57-mm-) diameter wire, or double strand of 0.048-inch- (1.22-mm-) diameter wire.

G. 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), and depth required to fit insulation thickness indicated.

1. Nominal Thickness: As required to meet performance requirements.

2.4 LAP-SEAM METAL WALL PANELS

A. General: Provide factory-formed metal wall panels designed to be field assembled by lapping side edges of adjacent panels and mechanically attaching panels to supports using exposed fasteners in side laps. Include accessories required for weather-tight installation.

Basis-of-Design Product: products as listed as manufactured by AEP-Span or a comparable product of one of the following:

a. Centria Architectural Systems.
b. Architectural Building Components.
c. ATAS International, Inc.
d. Berridge Manufacturing Company.
e. Fabral, Inc.
f. Metal-Fab Manufacturing, LLC.
g. Morin Corporation; a Metecno Group Company.

B. METAL PANEL TYPE 1

1. Basis-of-Design Product: Product: AEP-Span, HR-36 Wall Panel.
2. Panel :

a. Coverage: 36” net coverage.
b. Length: as required.
c. Material: Coated galvanized steel sheet, 22 gage (0.0329 inch).
d. Texture: Smooth.
e. Exterior Finish: 3 coat Fluoropolymer.
f. Color: Selected from manufacturer’s full range of colors.
g. Exposed fasteners: Matching color or stainless steel.
h. All vertical corners (inside and outside) to be fully welded.

3. Subgirt systems gage and spacing as required lateral loads
   a. Exterior and exterior: 25 PSF unless noted otherwise
   b. Corners: 35 PSF

C. METAL PANEL TYPE 2
1. Basis-of-Design Product: Product: AEP-Span, Mini-V-Beam.
   a. Coverage: 32" net coverage.
   b. Length: As required.
   c. Material: Coated galvanized steel sheet, 22 gauge (0.0329 inch).
   d. Texture: Smooth
   e. Exterior Finish: 3 coat Fluoropolymer.
   f. Color: As selected from manufacturer's full range of colors.
   g. Exposed Fasteners: Matching color.

2.5 METAL PANELS TYPE 3: Composite Panel

A. Basis-of-Design Product: Omega-Lite.
1. Polyallomer, corrugated core between two finished aluminum sheets
2. Thickness: 6 mm
3. Finishes: High-Performance Organic Finish (3-Coat Fluoropolymer): AA-C12C40R1x Manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions. Color as selected from manufacturer full standard

2.6 ACCESSORIES

A. Wall Panel Accessories: Provide components required for a complete metal wall panel assembly including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal wall panels, unless otherwise indicated.

1. Closures: Provide closures at eaves and rakes, fabricated of same metal as metal wall panels.
2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal wall panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Formed from minimum 22 guage thick, zinc-coated (galvanized) steel sheet or aluminum-zinc alloy-coated steel sheet prepainted with coil coating. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal wall panels.

2.7 MISCELLANEOUS MATERIALS

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners and self sealing washers designed to withstand design loads. Provide exposed fasteners with heads matching color of metal wall panels by means factory-applied coating unless noted otherwise.
   1. Fasteners for Wall Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal wall panels.
   2. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
   3. Blind Fasteners: High-strength aluminum or stainless-steel rivets.

B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

C. Panel Sealants:

   1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
   2. Joint Sealant: ASTM C 920; elastomeric polyurethane of type, grade, class, and use classifications required to seal joints in metal wall panels and remain weathertight; and as recommended in writing by metal wall panel manufacturer.
   3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311

2.8 FABRICATION

A. General: Fabricate and finish metal wall panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

   1. Form panel lines, breaks, and angles to be sharp and true, with surfaces free from warp and buckle.
   2. Fabricate wall panels with panel stiffeners as required to maintain fabrication tolerances and to withstand design loads.

B. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.

   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

5. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal wall panel manufacturer.

    a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal wall panel manufacturer for application but not less than thickness of metal being secured.

2.9 FINISHES, GENERAL

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

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, metal wall panel supports, and other conditions affecting performance of work.

1. Examine primary and secondary wall framing to verify that girts, angles, channels, studs, and other structural panel support members and anchorage have been installed within alignment tolerances required by metal wall panel manufacturer.
2. Examine solid wall sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal wall panel manufacturer.
3. Examine roughing-in for components and systems penetrating metal wall panels to verify actual locations of penetrations relative to seam locations of metal wall panels before metal wall panel installation.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Install flashings and other sheet metal to comply with requirements specified in Division 7 Section "Sheet Metal Flashing and Trim."

C. Miscellaneous Framing: Install subgirts, base angles, sills, furring, and other miscellaneous wall panel support members and anchorage according to ASTM C 754 and metal wall panel manufacturer's written recommendations.

3.3 METAL WALL PANEL INSTALLATION, GENERAL

A. Installer shall provide all equipment and materials necessary for the complete and operational install ion of products and materials described here. Any work, including supports, brackets, anchorage, miscellaneous steel, power disconnects, etc., not indicated on the drawings to be provided by others, shall be the responsibility of the installer

B. General: Install metal wall panels in orientation, sizes, and locations indicated on Drawings. Install panels perpendicular to girts and subgirts, unless otherwise indicated. Anchor metal wall panels and other components of the Work securely in place, with provisions for thermal and structural movement.

1. Field cutting of metal wall panels by torch is not permitted.
2. Shim or otherwise plumb substrates receiving metal wall panels.
3. Rigidly fasten base end of metal wall panels and allow eave end free movement due to thermal expansion and contraction. Predrill panels.
4. Flash and seal metal wall panels with weather closures at eaves, rakes, and at perimeter of all openings. Fasten with self-tapping screws. Do not begin installation until weather barrier and flashings that will be concealed by metal wall panels are installed.
5. Install screw fasteners in predrilled holes.
6. Locate and space fastenings in uniform vertical and horizontal alignment.
7. Install flashing and trim as metal wall panel work proceeds.
8. Locate panel splices over, but not attached to, structural supports. Stagger panel splices and end laps to avoid a four-panel lap splice condition.
9. Apply elastomeric sealant continuously between metal base channel (sill angle) and concrete, and elsewhere as indicated or, if not indicated, as necessary for waterproofing.
10. Align bottom of metal wall panels and fasten with blind rivets, bolts, or self-tapping screws. Fasten flashings and trim around openings and similar elements with self-tapping screws.
11. Provide weatherproof escutcheons for pipe and conduit penetrating exterior walls.
12. Locate cut edge at top edge of parapet concealed beneath copings where possible.

C. Fasteners:

1. Steel Wall Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.
2. Aluminum Wall Panels: Use aluminum or stainless-steel fasteners for surfaces exposed to the exterior and aluminum or galvanized steel fasteners for surfaces exposed to the interior.

D. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal wall panel manufacturer.

E. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal wall panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal wall panel manufacturer.

1. Seal metal wall panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal wall panel manufacturer.
2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

3.4 METAL PANEL TYPE 3 INSTALLATION

A. Install using “laminators Inc.” Clip & Caulk System

3.5 ACCESSORY INSTALLATION

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal wall panel assembly including trim, copings, corners, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

3.6 ERECTION TOLERANCES

A. Installation Tolerances: Shim and align metal wall panel units within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m), nonaccumulative, on level, plumb, and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 CLEANING AND PROTECTION

A. Remove temporary protective coverings and strippable films, if any, as metal wall panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal wall panel installation, clean finished surfaces as recommended by metal wall panel manufacturer. Maintain in a clean condition during construction.

B. After metal wall panel installation, clear weep holes and drainage channels of obstructions, dirt, and sealant.

C. Replace metal wall panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074213

SECTION 074610 - SIDING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including General and Supplementary Conditions, Division 1 Specifications, and Technical Specification Divisions 2 through 16 apply to this Section.

B. This project is to be LEED certified. Refer to Division 1 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SECTION INCLUDES

Factory finished fiber cement vertical siding, panels, single trim, fascia, moulding and accessories.

1.3 RELATED SECTION

A. Section 061600 - Rough Carpentry

1.4 REFERENCES

A. ASTM C1186 – Standard Specification for Flat Fiber-Cement Sheets

B. ASTM D3359 – Standard Test Method for Measuring Adhesion by Tape Test. Tool and Tape.

C. ASTM E136 – Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C.

1.5 SUBMITTALS

A. Submit under provisions of Section 013300

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured,

assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations
2. Storage and handling requirements and recommendations
3. Installation methods

D. Shop Drawings: Provide detailed drawings of atypical non-standard applications of cementitious siding materials which are outside the scope of the standard details and specification provided by the manufacturer.

E. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.

F. Verification Samples: For each finish product specified, two samples a minimum size 4 by 6 inches (100 by 150 mm), representing actual product, color, and patterns.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Minimum of 2 years experience with installation of similar products

B. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.

1. Finish areas designated by Architect.
2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store product in manufacturer’s unopened packaging until ready for installation.

B. Store siding on edge or lay flat on a smooth level surface. Protect edges and corners from chipping. Store sheets under cover and keep dry prior to installing.

C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having durisdiction.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits

recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. Product Warranty: Limited, non-pro-rated product warranty.

1. HardiPanel HZ5 vertical siding for 30 years.

B. Product Warranty: Limited, product warranty.

1. Hardie Trim HZ and HZ5 boards for 15 year.

C. Finish Warranty: Limited product warranty against manufacturing finish defect.

1. When used for its intended purpose, properly installed and maintained according to James Hardie's published installation instructions, James Hardie's ColorPlus finish with ColorPlus Technology, for a period of 15 years from date of purchase: will not peel; will not crack; and will not chip. Finish warranty includes the coverage for labor and material.

D. Workmanship Warranty: Application limited warranty for 2 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: James Hardie Building Product, Inc. which is located at: 26300 La Alameda Suite400: Mission Viejo, CA 92691; Toll Free Tel: 866-274-3464; Tel 949-367-4980; Email: request info (**info@jameshardie.com**) or approved equivalent.

B. Requests for approval of equal substitutions will be considered in accordance with provision of Division 0.

2.2 SIDING

A. Vertical Siding: HardiePanel HZ5 siding as manufactured by James Hardie Building Products, Inc.
1. Type: Smooth Vertical siding panel 4 feet by 10 feet (1219 mm by 3048 mm).

B. Trim:
1. HardieTrim HZ5 boards and Hardie Trim HZ boards as manufactured by James Hardie Building Products, Inc.
2. HardieTrim HZ5 Fascia boards as manufactured by James Hardie Building Products, Inc.

3. Hardie Trim HZ5 Crown moulding manufactured by James Hardie Building Products, Inc.
4. Artisan HZ5 Accent trim as manufactured by James Hardie Building Products, Inc.

2.3 FASTENERS

A. Wood Framing Fasteners:
1. Provide stainless steel fasteners, counter sunk, in size and pattern as suggested per manufacturer's recommendations and requirements.

2.4 FINISHES

A. Factory Finish: Refer to Exterior Finish Schedule.

1. Product: ColorPlus Technology by James Hardie.
2. Definition: Factory applied finish; defined as a finish applied in the sam facility and company that manufactures the siding substrate.
3. Process:
a. Factory applied finish by fiber cement manufacturer in a controlled environment within the fiber cement manufacturer's own facility utilizing a multi-coat, heat cured finish within one manufacturing process.
b. Each finish color must have documented color match to delta E of 0.5 or better between product lines, manufacturing lots or production runs as measured by photospectrometer and verified by third party.
4. Protection: Factory applied finish protection such as plastic laminate that is removed once siding is installed.
5. Accessories: Complete finishing system includes pre-packaged touch-up kit provided by fiber cement manufacturer. Provide quantities as recommended by manufacturer.

B. Factory Finish Color for Trim and Siding Colors:
1. As selected from manufacturer's standard colors. Preliminary color selection "light gray".

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. If framing preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation be fore proceeding.

C.

D. Nominal 2 inch by 4 inch (51 mm by 102 mm) wood framing selected for minimal shrinkage and complying with local building codes, including the use of water-resistive

barriers or vapor barriers where required. Minimum 1-1/2 inches (38 mm) face and straight, true, of uniform dimensions and properly aligned.

1. Install water-resistive barriers and claddings to dry surfaces.
2. Repair any punctures or tears in the water-resistive barrier prior to the installation of the siding.
3. Protect siding from other trades.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

C. Install a water-resistive barrier is required in accordance with local building code requrements.

D. The water-resistive barrier must be appropriately installed with penetration and junction flashing in accordance with local building code requirements.

E. Install Engineered for ClimateTM HardieWrapTM weather barrier in accordance with local code requirements.

F. Use HardieWrapTM Seam Tape and joint and laps.

G. Install HardieWrapTM flashing, and HardieWrapTM Flex Flashing.

3.3 INSTALLATION – HARDIEPANEL HZ5 VERTICAL SIDING

A. Install materials in strict accordance with manufacturer's instructions.

B. Block framing between studs where HardiePanel siding horizontal joints occur.

C. Install metal Z flashing and provide a ¼ inch (6 mm) gap at horizontal panel joints.

D. Place fasteners no closer than 3/8 inch (9.5 mm) from panel edges and 2 inches (51 mm) from panel corners.

E. Allow minimum vertical clearance between the edge of siding and any other material in strict accordance with the manufacturer’s installation instructions..

F. Maintain clearance between siding and adjacent finished grade.

G. Specific framing and fastener requirements refer to Tables 2 and 3 in National Evaluation Service Report No. NER-405.

H. Factory Finish Touch Up: Apply touch up paint to cut edges in accordance with manufacturer’s printed instructions.

1. Touch-up nicks, scrapes, and nail heads in pre-finished siding using the manufacturer's touch-up kit pen.
2. Touch-up of nails shall be performed after application, but beore plastic protection wrap is removed to prevent spotting of touch-up finish.
3. Use touch-up paint sparingly. If large areas require touch-up, replace the damaged area with new pre-finished siding. Match touch up color to siding color through use of manufacturer's branded touch-up kits.

3.4 FINISHING

A. Provide touch-up finish to any damaged finish and/or at all fasteners, and at exposed unfinished faces with manufacturer's approved paint repair kit matching factory finish color as approved by Architect. Install per manufacturer's standard instructions.

3.5 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 074610

SECTION 075323 - EPDM MEMBRANE ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements,” “Construction Waste Managements” and “Commissioning Requirements,” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Adhered membrane roofing system.
2. Roof insulation
3. Cover board.

B. Refer to Division 1 Section “ALTERNATES” for listing of Bid alternates that may affect the work described herein.

C. Related Sections include the following:

1. Division 6 Section "Miscellaneous Carpentry" for wood nailers, curbs, and blocking.
2. Division 7 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
3. Division 7 Section "Joint Sealants."
4. Division 22 Section "Plumbing" for roof drains.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," before multiplication by a safety factor.

C. Factored Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," after multiplication by a safety factor.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by roofing membrane manufacturer based on testing and field experience.

C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist the factored design uplift pressures calculated according to SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems."

1. Corner Design Uplift Pressure: 50 lbf/sq. ft.
2. Perimeter Design Uplift Pressure: 50 lbf/sq. ft.
3. Field-of-Roof Design Uplift Pressure: 35 lbf/sq. ft.
4. Safety Factor: Per ASCE 7.

1.5 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work.

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Insulation fastening patterns.

D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

1. Submit evidence of meeting performance requirements.

F. Samples for Verification:

1. Fasteners for use with pressure treated wood blocking
2. Upon request, provide samples of roofing components and materials.

G. Qualification Data: For Installer and manufacturer.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of roofing system.

I. Research/Evaluation Reports: For components of membrane roofing system.

J. Maintenance Data: For roofing system to include in maintenance manuals.

K. Warranties: Special warranties specified in this Section.

L. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty.

B. Manufacturer Qualifications: A qualified manufacturer that has UL listing or FMG approval for membrane roofing system identical to that used for this Project.

C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

D. Technical Inspector Qualifications: Engage an experienced technical inspector to perform Work of this Section who has specialized in inspecting roofing similar to that required for this Project; who is employed by the roofing system manufacturer to inspect manufacturer’s project. If the manufacturer does not employ full-time technical inspectors, approved inspector must be certified as a Registered Roof Observer by the Roof Consultants Institute.

E. Source Limitations: Obtain components for membrane roofing system approved by roofing membrane manufacturer.

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

1. Exterior Fire-Test Exposure: Class A ASTM E 108, for application and roof slopes indicated.

2. Fire-Resistance Ratings: ASTM E 119, for fire-resistance-rated roof assemblies of which roofing system is a part.

G. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 1 Section "Project Management and Coordination." Review methods and procedures related to roofing system including, but not limited to, the following:

1. Meet with Owner; Architect; Owner's insurer if applicable; testing and inspecting agency representative; roofing Installer; roofing system manufacturer's representative; deck Installer; and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.8 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Special warranty includes roofing membrane, base flashings, roofing accessories, roof insulation, fasteners, cover boards, substrate board, walkway products, and other components of membrane roofing system.
2. Warranty Period: 15 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including all components of membrane roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.
3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 EPDM ROOFING MEMBRANE

A. EPDM Roofing Membrane: ASTM D 4637, Type II, uniform, flexible sheet made from EPDM, Basis-of-Design: Carlisle, Sure-White.

1. Thickness: 60 mils (1.5 mm)
2. Exposed Face Color: white
3. Available Manufacturers:

    a. Celotex Corporation.
    b. Firestone Building Products Company.
    c. Johns Manville International, Inc.
    d. Mule-Hide Products Co., Inc.
    e. Versico Inc.

2.3 AUXILIARY MATERIALS

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.

    1. Liquid-type auxiliary materials shall meet VOC limits of authorities having jurisdiction.

B. Sheet Flashing: 60-mil- (1.5-mm-) thick EPDM, partially cured or cured, according to application.

C. Epichlorohydrin Sheet: 60-mil- (1.5-mm-) thick, unreinforced flexible sheet with the following typical properties as determined per ASTM test method indicated:

    1. Tensile Strength: 1500 psi (10.3 MPa); ASTM D 412.
    2. Ultimate Elongation: 200 percent; ASTM D 412.
    3. Tear Resistance: 150 lbf/in. (26.3 kN/m); ASTM D 412.
    4. Brittleness Temperature: Minus 20 deg F (Minus 29 deg C); ASTM D 746.
    5. Resistance to Ozone Aging: No cracks after 168 hours' exposure of 50 percent elongated sample at 104 deg F (40 deg C) and 100-pphm (100-MPa) ozone; ASTM D 1149.
    6. Resistance to Oil Aging: 15 percent maximum mass change after 168 hours' immersion in diesel fuel No. 2 at 158 deg F (70 deg C); ASTM D 471.

D. Bonding Adhesive: Manufacturer's standard bonding adhesive.

E. Seaming Material: Single-component butyl splicing adhesive and splice cleaner

F. Lap Sealant: standard single-component sealant as recommended by Manufacturer. color to match roofing membrane.

G. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.

H. Metal Termination Bars: Manufacturer's standard predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

I. Metal Battens: Manufacturer's standard aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch (25 mm) wide by 0.05 inch (1.3 mm) thick, prepunched.

J. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

K. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.

2.4 ROOF INSULATION

A. General: Provide preformed roof insulation boards that comply with requirements and referenced standards, selected from manufacturer's standard sizes and of thicknesses indicated.

B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1 felt or glass-fiber mat facer on both major surfaces. Minimum thickness 6 inches. (except at drains) r = 5.6 per inch.

1. Available Manufacturers:

a. Apache Products Company.
b. Atlas Roofing Corporation.
c. Carlisle SynTec Incorporated.
d. Celotex Corporation.
e. Firestone Building Products Company.
f. GAF Materials Corp.
g. GenFlex Roofing Systems.
h. Johns Manville International, Inc.
i. Koppers Industries.
j. RMAX.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of Typical 1/4 inch per 12 inches (1:48) unless otherwise indicated. (Provide 1.5 and 2” base insulation at tapered insulation)

D. Cricket material as required to achieve minimum finish slope of 1/2 inch per 12 inches unless otherwise indicated.

E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.5 INSULATION ACCESSORIES

A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatible with membrane roofing.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer. At pressure treated wood blocking use non-metallic or stainless steel fasteners and plates.

C. Cold Fluid-Applied Adhesive: Manufacturer's standard cold fluid-applied adhesive formulated to adhere roof insulation to substrate.

D. Cover Board: ASTM C 208, Type II, Grade 2, cellulosic-fiber insulation board, 1/2 inch (13 mm) thick.

E. Metal Securement System: Perimeter securement flashing and strapping fabricated from stainless steel, a minimum of 0.031 inch (0.8 mm) thick. Provide fasteners as recommended by mortar-faced insulation manufacturer.

2.6 WALKWAYS

A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick, and acceptable to membrane roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:

1. Verify that roof openings and penetrations are in place and set and braced and that roof drains are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Deck."

3.2 PREPARATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

D. Confirm placement of acoustical roof deck rib insulation strips, specified in Division 5 Section "Steel Deck," prior to proceeding.

3.3 INSULATION INSTALLATION

A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with membrane roofing system manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install one or more layers of insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2 inches (50 mm) or greater, install 2 or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Loosely Laid Insulation: Loosely lay insulation units.

H. Adhered Insulation: Install each layer of insulation and adhere to substrate as follows:
1. Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
2. Set each layer of insulation in a cold fluid-applied adhesive.

I. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
3. Install subsequent layers of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.
4. Install subsequent layers of insulation in a cold fluid-applied adhesive.

J. Install cover boards over insulation and areas to be re-roofed with long joints in continuous straight lines with end joints staggered between rows. Loosely butt cover boards together and fasten to roof deck.

1. Fasten insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.
2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.

3.4 ADHERED ROOFING MEMBRANE INSTALLATION

A. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.

B. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.

C. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

D. Bonding Adhesive: Apply bonding adhesive to substrate and underside of roofing membrane at rate required by manufacturer and allow to partially dry before installing roofing membrane. Do not apply bonding adhesive to splice area of roofing membrane.

E. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer and install fleece-backed roofing membrane. Do not apply roofing asphalt to splice area of roofing membrane.

F. Mechanically or adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.

G. Apply roofing membrane with side laps shingled with slope of roof deck where possible.

H. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.

1. Apply a continuous bead of in-seam sealant before closing splice if required by membrane roofing system manufacturer.

I. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping roofing membranes according to manufacturer's written instructions to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of roofing membrane terminations.

J. Repair tears, voids, and lapped seams in roofing that does not meet requirements.

K. Spread sealant or mastic bed over deck drain flange at deck drains and securely seal roofing membrane in place with clamping ring.

L. Install roofing membrane and auxiliary materials to tie in to existing roofing.

M. Apply epichlorohydrin sheet over roofing membrane at locations indicated or required.

3.5 BASE FLASHING INSTALLATION

A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply bonding adhesive to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

F. Roof Drains: Refer to NRCA Construction Detail TS-22 and TS-22S

G. Metal Parapet Cap (Coping) and Base Flashing: Refer to NRCA Construction Detail TS-7 and TS-7S.

H. Curb Flashing: Refer to NRCA Construction Detail TS-14 and TS-14S.

I. Plumbing Vent: Refer to NRCA Construction Detail TS-20A and TS 20AS.

J. Pitch Pocket: Refer to NRCA Construction Detail TS-21 and TS-21S.

K. Equipment Stand: Refer to NRCA Construction Detail TS-14 and TS-14S.

3.6 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Owner reserves the right, will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports

B. Manufacturer’s Technical Representative: Contractor will engage a qualified manufacturer’s technical representative for a minimum of 2 days to perform roof tests and inspections and to prepare test reports.

C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.

1. Notify Architect or Owner 48 hours in advance of date and time of inspection.

D. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.8 PROTECTING AND CLEANING

A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.9 ROOFING INSTALLER'S WARRANTY

A. WHEREAS <Insert name> of <Insert address>, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: <Insert name of Owner.>
2. Address: <Insert address.>
3. Building Name/Type: <Insert information.>
4. Address: <Insert address.>
5. Area of Work: <Insert information.>
6. Acceptance Date: <Insert date.>
7. Warranty Period: <Insert time.>
8. Expiration Date: <Insert date.>

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

    a. lightning;
    b. peak gust wind speed exceeding 90 mph (m/sec);
    c. fire;
    d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
    e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
    f. vapor condensation on bottom of roofing; and
    g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.

2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.

1. Authorized Signature: <Insert signature.>
2. Name: <Insert name.>
3. Title: <Insert title.>

END OF SECTION 075323

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following sheet metal flashing and trim:

1. Manufactured through-wall flashing.
2. Manufactured reglets.
3. Formed roof drainage system.
4. Formed low-slope roof flashing and trim.
5. Formed steep-slope roof flashing and trim.
6. Formed wall flashing and trim.
7. Formed equipment support flashing.
8. Formed overhead-piping safety pans.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for installing reglets.
2. Division 4 Section "Unit Masonry Assemblies" for installing through-wall flashing, reglets, and other sheet metal flashing and trim.
3. Division 5 Section "Architectural Joint Systems" for manufactured sheet metal expansion-joint covers.
4. Division 6 Section "[Rough Carpentry] [Miscellaneous Carpentry]" for wood nailers, curbs, and blocking.
5. Division 7 Section "<Insert Section title for roof shingles, shakes, or tiles>" for installing sheet metal flashing and trim integral with roofing.
6. Division 7 Section "Metal Roof Panels" for factory-formed metal roof panels and flashing and trim not part of sheet metal flashing and trim.
7. Division 7 Section "Metal Wall Panels" for factory-formed metal wall panels and flashing and trim not part of sheet metal flashing and trim.
8. Division 7 Section "<Insert Section title for type of membrane roofing system>" for installing sheet metal flashing and trim integral with roofing membrane.
9. Division 7 Section "Sheet Metal Roofing" for custom-formed sheet metal roofing and flashing and trim not part sheet metal flashing and trim.

10. Division 7 Section "Manufactured Roof Specialties" for manufactured roof specialties not part of sheet metal flashing and trim.
11. Division 7 Section "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units.
12. Division 7 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing, rattling, leaking, and fastener disengagement.

B. Fabricate and install [roof edge flashing] [and] [copings] capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:

1. Wind Zone 1: For velocity pressures of 10 to 20 lbf/sq. ft. (0.48 to 0.96 kPa): 40-lbf/sq. ft. (1.92-kPa) perimeter uplift force, 60-lbf/sq. ft. (2.87-kPa) corner uplift force, and 20-lbf/sq. ft. (0.96-kPa) outward force.
2. Wind Zone 1: For velocity pressures of 21 to 30 lbf/sq. ft. (1.00 to 1.44 kPa): 60-lbf/sq. ft. (2.87-kPa) perimeter uplift force, 90-lbf/sq. ft. (4.31-kPa) corner uplift force, and 30-lbf/sq. ft. (1.44-kPa) outward force.
3. Wind Zone 2: For velocity pressures of 31 to 45 lbf/sq. ft. (1.48 to 2.15 kPa): 90-lbf/sq. ft. (4.31-kPa) perimeter uplift force, 120-lbf/sq. ft. (5.74-kPa) corner uplift force, and 45-lbf/sq. ft. (2.15-kPa) outward force.
4. Wind Zone 3: For velocity pressures of 46 to 104 lbf/sq. ft. (2.20 to 4.98 kPa): 208-lbf/sq. ft. (9.96-kPa) perimeter uplift force, 312-lbf/sq. ft. (14.94-kPa) corner uplift force, and 104-lbf/sq. ft. (4.98-kPa) outward force.

C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Water Infiltration: Provide sheet metal flashing and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Include the following:

1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Details of expansion-joint covers, including showing direction of expansion and contraction.

D. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.

1. Include similar Samples of trim and accessories involving color selection.

E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:

1. Sheet Metal Flashing: 12 inches (300 mm) long. Include fasteners, [cleats,] [clips,] closures, and other attachments.
2. Trim: 12 inches (300 mm) long. Include fasteners and other exposed accessories.
3. Accessories: Full-size Sample.

1.5 QUALITY ASSURANCE

A. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

1. Copper Standard: Comply with CDA's "Copper in Architecture Handbook."

B. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockup of typical roof eave[, including built-in gutter] [fascia] [fascia trim] [apron flashing], approximately 48 inches (1200 mm) long, including supporting construction cleats, seams, attachments[, underlayment,] and accessories.

2. Approval of mockups is for other material and construction qualities specifically approved by Architect in writing.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
2. Review methods and procedures related to sheet metal flashing and trim.
3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.

B. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.

1.7 COORDINATION

A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.

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. Products: Subject to compliance with requirements, provide one of the products specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SHEET METALS

A. Copper Sheet: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet.

B. Lead-Coated Copper Sheet: ASTM B 101, Temper H00 and H01, cold-rolled copper sheet, of weight (thickness) indicated below, coated both sides with lead weighing not less than 12 lb/100 sq. ft. (0.59 kg/sq. m) nor more than 15 lb/100 sq. ft. (0.73 kg/sq. m) of copper sheet (total weight of lead applied equally to both sides).

C. Aluminum Sheet: ASTM B 209 (ASTM B 209M), Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:

1. Mill Finish: [One-side] [Standard one-side] [Standard two-sides] bright.
2. Alclad Finish: Metallurgically bonded surfacing to both sides, forming a composite aluminum sheet with reflective luster.
3. Factory Prime Coating: Where painting after installation is indicated, provide pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat; with a minimum dry film thickness of 0.2 mil (0.005 mm).
4. Siliconized-Polyester Coating: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

    a. Color: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

5. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

    a. Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA [2604] [2605].
    b. Fluoropolymer 3-Coat System: Manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a

minimum total dry film thickness of 1.5 mil (0.038 mm); complying with AAMA 2605.

1) Color: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

6. Anodized Finish: Apply the following coil-anodized finish:

a. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
b. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
c. Class II, Color Anodic Finish: AA-M12C22A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
d. Class I, Color Anodic Finish: AA-M12C22A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

1) Color: [Light bronze] [Medium bronze] [Dark bronze] [Black].

D. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.

1. Finish: No. [2D (dull, cold rolled)] [2B (bright, reflective)] [3 (reflective, polished directional satin)] [4 (fine reflective, polished directional satin)].

E. Zinc-Tin Alloy-Coated Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304, dead-soft, fully annealed stainless-steel sheet, coated on both sides with a zinc-tin alloy (50 percent zinc, 50 percent tin).

1. Product: Subject to compliance with requirements, provide "TCS II" by Follansbee Steel.

F. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality[, mill phosphatized for field painting].

G. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality[with manufacturer's standard clear acrylic coating both sides].

H. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.

2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
3. Exposed Finishes: Apply the following coil coating:

    a. Factory Prime Coating: Where painting after installation is indicated, provide pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat; with a minimum dry film thickness of 0.2 mil (0.005 mm).
    b. Siliconized-Polyester Coating: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than 0.2 mil (0.005 mm) for primer and 0.8 mil (0.02 mm) for topcoat.

        1) Color: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

    c. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

        1) Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA [2604] [2605], except as modified below:

            a) Humidity Resistance: [1000] [2000] hours.
            b) Salt-Spray Resistance: [1000] [2000] hours.

        2) Fluoropolymer 3-Coat System: Manufacturer's standard 3-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight, with a minimum total dry film thickness of 1.5 mil (0.038 mm); complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:

            a) Humidity Resistance: [1000] [2000] hours.
            b) Salt-Spray Resistance: [1000] [2000] hours.

        3) Color: [As indicated by manufacturer's designations] [Match Architect's samples] [As selected by Architect from manufacturer's full range].

I. Lead Sheet: ASTM B 749, Type L51121, copper-bearing lead sheet.

J. Zinc Sheet: Electrolytic, 99 percent pure zinc alloyed with 1 percent titanium and copper.

1. Finish: [Bright rolled] [Preweathered].

2.3 UNDERLAYMENT MATERIALS

A. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.

B. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

C. Slip Sheet: Rosin-sized paper, minimum 3 lb/100 sq. ft. (0.16 kg/sq. m).

2.4 MISCELLANEOUS MATERIALS

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.

B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.

1. Nails for Copper Sheet: Copper, hardware bronze, or Series 300 stainless steel, 0.109 inch (2.8 mm) minimum and not less than 7/8 inch (22 mm) long, barbed with large head.
2. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head.
4. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
5. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.

C. Solder for Copper: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

D. Solder for Lead-Coated Copper: ASTM B 32, Grade Sn60, 60 percent tin and 40 percent lead.

E. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.

F. Solder for Zinc-Tin Alloy-Coated Stainless Steel: ASTM B 32, 100 percent tin.

G. Solder for Lead: ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead.

H. Solder for Zinc: ASTM B 32, 60 percent lead and 40 percent tin with low antimony, as recommended by manufacturer.

I. Burning Rod for Lead: Same composition as lead sheet.

J. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

K. Elastomeric Sealant: ASTM C 920, elastomeric [polyurethane] [polysulfide] [silicone] polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

L. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.

M. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.

N. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

O. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

A. Through-Wall Ribbed Sheet Metal Flashing: Manufacture through-wall sheet metal flashing for embedment in masonry with ribs at 3-inch (75-mm) intervals along length of flashing to provide an integral mortar bond.[Manufacture through-wall flashing with snaplock receiver on exterior face to receive counterflashing.]

1. Copper: 10 oz. (0.34 mm thick) minimum for fully concealed flashing; 16 oz. (0.55 mm thick) elsewhere.

    a. [Available]Products:

        1) Advanced Building Products Inc.; Cop-R-Loc Interlocking Flashing.
        2) Cheney Flashing Company, Inc.; Cheney Flashing (Dovetail).
        3) Cheney Flashing Company, Inc.; Cheney Flashing (Sawtooth).
        4) Dur-O-Wal, Dayton Superior Corporation; Polytite Copper Flashing.
        5) Keystone Flashing Company, Inc.; Keystone Three-Way Interlocking Thruwall Flashing.
        6) Sandell Manufacturing Company, Inc.; Three-Way Saw Tooth Flashing.
        7) York Manufacturing, Inc.; Cop-R-Loc Interlocking Flashing.
        8) <Insert manufacturer's name; product.>

2. Stainless Steel: 0.0156 inch (0.4 mm) thick.

    a. [Available]Products:

        1) Cheney Flashing Company, Inc.; Cheney Flashing (Dovetail).
        2) Cheney Flashing Company, Inc.; Cheney Flashing (Sawtooth).
        3) Keystone Flashing Company, Inc.; Keystone Three-Way Interlocking Thruwall Flashing.

B. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated[with factory-mitered and -welded corners and junctions].

1. [Available]Manufacturers:

    a. Cheney Flashing Company, Inc.
    b. Fry Reglet Corporation.
    c. Heckmann Building Products Inc.
    d. Hickman, W. P. Company.
    e. Keystone Flashing Company, Inc.
    f. Sandell Manufacturing Company, Inc.
    g. <Insert manufacturer's name.>

2. Material: [Stainless steel, 0.0187 inch (0.5 mm) thick] [Copper, 16 oz./sq. ft. (0.55 mm thick)] [Lead-coated copper, 17.2 oz./sq. ft. (0.60 mm thick)] [Aluminum, 0.024 inch (0.6 mm) thick] [Galvanized steel, 0.0217 inch (0.55 mm) thick].
3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
4. Stucco Type: Provide with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
5. Concrete Type: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
6. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
7. Flexible Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
8. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.6 FABRICATION, GENERAL

A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.

B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

C. Fabricate 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.

1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.

D. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.

E. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with [elastomeric] [butyl] sealant concealed within joints.

F. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.

G. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual"[and FMG Loss Prevention Data Sheet 1-49] for application but not less than thickness of metal being secured.

2.7 ROOF DRAINAGE SHEET METAL FABRICATIONS

A. Hanging Gutters: Fabricate to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Fabricate expansion joints, expansion-joint covers,[gutter bead reinforcing bars,] and gutter accessories from same metal as gutters.

1. Gutter Style: [A] [B] [C] [D] [E] [F] [G] [H] [I] [J].
2. Expansion Joints: [Lap type] [Butt type] [Built in].
3. Accessories: [Continuous removable leaf screen with sheet metal frame and hardware cloth screen] [Bronze wire ball downspout strainer] [Wire ball downspout strainer] [Valley baffles].
4. Gutters with Girth up to 15 Inches (380 mm): Fabricate from the following material:
    a. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
    b. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
    c. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
    d. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
    e. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
    f. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
    g. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
    h. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
    i. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.
5. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Fabricate from the following material:

a. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.040 inch (1.0 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
i. Zinc: [0.040 inch (1.0 mm)] [0.050 inch (1.2 mm)] <Insert thickness> thick.

6. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following material:

a. Copper: [20 oz./sq. ft. (0.7 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [21.2 oz./sq. ft. (0.75 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.050 inch (1.2 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0336 inch (0.85 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0336 inch (0.85 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0336 inch (0.85 mm)] <Insert thickness> thick.
i. Zinc: [0.050 inch (1.2 mm)] [0.060 inch (1.5 mm)] <Insert thickness> thick.

7. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following material:

a. Copper: [24 oz./sq. ft. (0.82 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [25 oz./sq. ft. (0.87 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.063 inch (1.6 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0312 inch (0.8 mm)] <Insert thickness> thick.
e. Galvanized Steel: [0.040 inch (1.0 mm)] <Insert thickness> thick.
f. Prepainted, Metallic-Coated Steel: [0.040 inch (1.0 mm)] <Insert thickness> thick.

8. Gutters with Girth 31 to 35 Inches (790 to 890 mm): Fabricate from the following material:

a. Copper: [24 oz./sq. ft. (0.82 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [25 oz./sq. ft. (0.87 mm thick)] <Insert weight or thickness>.
c. Stainless Steel: [0.0375 inch (0.95 mm)] <Insert thickness> thick.
d. Galvanized Steel: [0.0516 inch (1.3 mm)] <Insert thickness> thick.

e. Prepainted, Metallic-Coated Steel: [0.0516 inch (1.3 mm)] <Insert thickness> thick.

B. Built-in Gutters: Fabricate to cross section indicated, with riveted and soldered joints, complete with end pieces, outlet tubes, and other special accessories as required. Fabricate in minimum 96-inch- (2400-mm-) long sections. Fabricate expansion joints and accessories from same metal as gutters, unless otherwise indicated.

1. Fabricate gutters with built-in expansion joints[and gutter-end expansion joints at walls].
2. Accessories: [Continuous removable leaf screen with sheet metal frame and hardware cloth screen] [Bronze wire ball downspout strainer] [Wire ball downspout strainer].
3. Fabricate built-in gutters from the following material:

a. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
c. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
d. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
e. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

C. Downspouts: Fabricate [round] [rectangular] [open-face] downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Manufactured Hanger Style: <Insert description.>
2. Fabricate downspouts from the following material:

a. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.024 inch (0.6 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
i. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

D. Parapet Scuppers: Fabricate scuppers of dimensions required with closure flange trim to exterior, 4-inch- (100-mm-) wide wall flanges to interior, and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.

1. Fabricate parapet scuppers from the following material:

a. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.

c. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
i. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

E. Conductor Heads: Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shape indicated complete with outlet tubes[, exterior flange trim] [, and] [built-in overflows].

1. Fabricate conductor heads from the following material:

a. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
i. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

2.8 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

A. Roof Edge Flashing (Gravel Stop) and Fascia Caps: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Furnish with 6-inch- (150-mm-) wide joint cover plates.

1. Joint Style: [Lap, 4 inches (100 mm) wide] [Butt, with 12-inch- (300-mm-) wide concealed backup plate] [Butt, with 6-inch- (150-mm-) wide exposed cover plates] [Butt, with 12-inch- (300-mm-) wide concealed backup plate and 6-inch- (150-mm-) wide exposed cover plates].
2. Fabricate with scuppers spaced 10 feet (3 m) <Insert spacing> apart, of dimensions required with 4-inch- (100-mm-) wide flanges and base extending 4 inches (100 mm) beyond cant or tapered strip into field of roof. Fasten gravel guard angles to base of scupper.
3. Fabricate scuppers from the following material:

a. Copper: [20 oz./sq. ft. (0.7 mm thick)] <Insert weight or thickness>.

b. Lead-Coated Copper: [21.2 oz./sq. ft. (0.75 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.050 inch (1.2 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
i. Zinc: [0.050 inch (1.2 mm)] [0.060 inch (1.5 mm)] <Insert thickness> thick.

B. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) long, sections. Fabricate joint plates of same thickness as copings. Furnish with continuous cleats to support edge of external leg and[drill elongated holes for fasteners on] interior leg. Miter corners, seal, and solder or weld watertight.

1. Joint Style: [Butt, with 12-inch- (300-mm-) wide concealed backup plate] [Butt, with 6-inch- (150-mm-) wide exposed cover plates] [Butt, with 12-inch- (300-mm-) wide concealed backup plate and 6-inch- (150-mm-) wide exposed cover plates].
2. Fabricate copings from the following material:

a. Copper: [24 oz./sq. ft. (0.82 mm thick)] <Insert weight or thickness>.
b. Lead-Coated Copper: [25 oz./sq. ft. (0.87 mm thick)] <Insert weight or thickness>.
c. Aluminum: [0.050 inch (1.2 mm)] <Insert thickness> thick.
d. Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
e. Zinc-Tin Alloy-Coated Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
f. Galvanized Steel: [0.0396 inch (1.0 mm)] <Insert thickness> thick.
g. Aluminum-Zinc Alloy-Coated Steel: [0.0396 inch (1.0 mm)] <Insert thickness> thick.
h. Prepainted, Metallic-Coated Steel: [0.0396 inch (1.0 mm)] <Insert thickness> thick.
i. Zinc: [0.050 inch (1.2 mm)] [0.060 inch (1.5 mm)] <Insert thickness> thick.

C. [Roof] [and] [Roof to Wall Transition] [Roof to Sheet Metal Roof Edging Transition] Expansion-Joint Cover: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.050 inch (1.2 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0336 inch (0.85 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0336 inch (0.85 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0336 inch (0.85 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

D. Base Flashing: Fabricate from the following material:

1. Copper: [20 oz./sq. ft. (0.7 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [21.2 oz./sq. ft. (0.75 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.040 inch (1.0 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

E. Counterflashing: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

F. Flashing Receivers: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

G. Roof-Penetration Flashing: Fabricate from the following material:

1. Lead: [4.0 lb/sq. ft. (1.6 mm thick)] <Insert weight or thickness>, hard tempered.
2. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
3. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

H. Splash Pans: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.040 inch (1.0 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

I. Roof-Drain Flashing: Fabricate from the following material:

1. Lead: [4.0 lb/sq. ft. (1.6 mm thick)] <Insert weight or thickness>, hard tempered.
2. Copper: [13.2 oz./sq. ft. (0.45 mm thick)] <Insert weight or thickness>.
3. Lead-Coated Copper: [12 oz./sq. ft. (0.4 mm thick)] <Insert weight or thickness>.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.

2.9 STEEP-SLOPE ROOF SHEET METAL FABRICATIONS

A. Apron, Step, Cricket, and Backer Flashing: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

B. Valley Flashing: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
4. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
5. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
6. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

C. Drip Edges: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

D. Eave, Rake[, Ridge, and Hip] Flashing: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

E. Base Flashing: Fabricate from the following material:

1. Copper: [20 oz./sq. ft. (0.7 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [21.2 oz./sq. ft. (0.75 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.040 inch (1.0 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

F. Counterflashing: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

G. Flashing Receivers: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

H. Roof-Penetration Flashing: Fabricate from the following material:

1. Lead: [4.0 lb/sq. ft. (1.6 mm thick)] <Insert weight or thickness>, hard tempered.
2. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
3. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

2.10 WALL SHEET METAL FABRICATIONS

A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch- (2400-mm-) long, but not exceeding 12 foot (3.6 m) long, sections, under copings, at shelf angles, and where indicated. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches (150 mm) beyond each side of wall openings. Form with 2-inch- (50-mm-) high end dams. Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
4. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

B. Openings Flashing in Frame Construction: Fabricate head, sill,[jamb,] and similar flashings to extend [4 inches (100 mm)] <Insert extension> beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high end dams. Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.0320 inch (0.8 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0156 inch (0.4 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.015 inch (0.4 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0217 inch (0.55 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

C. Wall Expansion-Joint Cover: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Aluminum: [0.040 inch (1.0 mm)] <Insert thickness> thick.
4. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
5. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
6. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
7. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
8. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
9. Zinc: [0.031 inch (0.80 mm)] [0.040 inch (1.0 mm)] <Insert thickness> thick.

2.11 MISCELLANEOUS SHEET METAL FABRICATIONS

A. Equipment Support Flashing: Fabricate from the following material:

1. Copper: [16 oz./sq. ft. (0.55 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [17.2 oz./sq. ft. (0.60 mm thick)] <Insert weight or thickness>.
3. Stainless Steel: [0.0187 inch (0.5 mm)] <Insert thickness> thick.
4. Zinc-Tin Alloy-Coated Stainless Steel: [0.018 inch (0.5 mm)] <Insert thickness> thick.
5. Galvanized Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
6. Aluminum-Zinc Alloy-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.
7. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.

B. Overhead-Piping Safety Pans: Fabricate from the following material:

1. Copper: [24 oz./sq. ft. (0.82 mm thick)] <Insert weight or thickness>.
2. Lead-Coated Copper: [25 oz./sq. ft. (0.87 mm thick)] <Insert weight or thickness>.
3. Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
4. Zinc-Tin Alloy-Coated Stainless Steel: [0.0250 inch (0.65 mm)] <Insert thickness> thick.
5. Galvanized Steel: [0.0396 inch (1.0 mm)] <Insert thickness> thick.
6. Prepainted, Metallic-Coated Steel: [0.0276 inch (0.7 mm)] <Insert thickness> thick.

2.12 FINISHES

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

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.

1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.

1. Torch cutting of sheet metal flashing and trim is not permitted.

B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.

1. Coat side of [uncoated aluminum] [stainless-steel] [and] [lead] sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required for waterproof performance.

C. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.

D. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and [elastomeric] [butyl] sealant.

E. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

1. Space cleats not more than 12 inches (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.

F. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with [elastomeric] [butyl] sealant concealed within joints.

G. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.

1. Galvanized or Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
2. Aluminum: Use aluminum or stainless-steel fasteners.
3. Copper: Use copper, hardware bronze, or stainless-steel fasteners.
4. Stainless Steel: Use stainless-steel fasteners.

H. Seal joints with [elastomeric] [butyl] sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

I. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Pretin edges of sheets to be soldered to a width of 1-1/2 inches (38 mm) except where pretinned surface would show in finished Work.

1. Do not solder [prepainted, metallic-coated steel] [and] [aluminum] sheet.
2. Pretinning is not required for [lead-coated copper] [zinc-tin alloy-coated stainless steel] [and] [lead].
3. Stainless-Steel Soldering: Pretin edges of uncoated sheets to be soldered using solder recommended for stainless steel and phosphoric acid flux. Promptly wash off acid flux residue from metal after soldering.
4. Copper Soldering: Tin uncoated copper surfaces at edges of sheets using solder recommended for copper work.
5. Where surfaces to be soldered are lead coated, do not tin edges, but wire brush lead coating before soldering.
6. Lead-Coated Copper Soldering: Wire brush edges of sheets before soldering.
7. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

J. Aluminum Flashing: Rivet or weld joints in uncoated aluminum where necessary for strength.

3.3 ROOF DRAINAGE SYSTEM INSTALLATION

A. General: Install sheet metal roof drainage items to produce complete roof drainage system according to SMACNA recommendations and as indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters: Join sections with riveted and soldered joints or with lapped joints sealed with [elastomeric] [butyl] sealant. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchored [gutter brackets] [straps] spaced not more than 36 inches (900 mm) apart. Provide end closures and seal watertight with sealant. Slope to downspouts.

1. Fasten gutter spacers to front and back of gutter.
2. Loosely lock straps to front gutter bead and anchor to roof deck.
3. Anchor and loosely lock back edge of gutter to continuous [cleat] [eave or apron flashing].
4. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
5. Anchor gutter with spikes and ferrules spaced not more than [24 inches (600 mm)] [30 inches (750 mm)] apart.

6. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.24 m) apart. Install expansion joint caps.
7. Install continuous gutter screens on gutters with noncorrosive fasteners, [removable] [hinged to swing open] for cleaning gutters.

C. Built-in Gutters: Join sections with riveted and soldered or lapped joints sealed with [elastomeric] [butyl] sealant. Provide for thermal expansion. Slope to downspouts. Provide end closures and seal watertight with sealant.

1. Install felt underlayment layer in built-in gutter trough and extend to drip edge at eaves and under felt underlayment on roof sheathing. Lap sides a minimum of 2 inches (50 mm) over underlying course. Lap ends a minimum of 4 inches (100 mm). Stagger end laps between succeeding courses at least 72 inches (1830 mm). Fasten with roofing nails. Install slip sheet over felt underlayment.
2. Anchor and loosely lock back edge of gutter to continuous [cleat] [eave or apron flashing].
3. Anchor back of gutter that extends onto roof deck with cleats spaced not more than 24 inches (600 mm) apart.
4. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.24 m) apart. Install expansion joint caps.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1500 mm) o.c. in between.

1. Provide elbows at base of downspout to direct water away from building.
2. Connect downspouts to underground drainage system indicated.

E. Parapet Scuppers: Install scuppers where indicated through parapet. Continuously support scupper, set to correct elevation, and seal flanges to interior wall face, over cants or tapered edge strips, and under roofing membrane.

1. Anchor scupper closure trim flange to exterior wall and seal or solder to scupper.
2. Loosely lock front edge of scupper with conductor head.
3. Seal or solder exterior wall scupper flanges into back of conductor head.

F. Conductor Heads: Anchor securely to wall with elevation of conductor head rim 1 inch (25 mm) below [scupper] [gutter] discharge.

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

H. Splash Pans: Install where downspouts discharge on low-sloped roofs. Set in [asphalt roofing cement] [elastomeric sealant] [butyl sealant] compatible with roofing membrane.

3.4 ROOF FLASHING INSTALLATION

A. General: Install sheet metal roof flashing and trim to comply with performance requirements[, sheet metal manufacturer's written installation instructions,] and SMACNA's "Architectural

Sheet Metal Manual." 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.

B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.

1. Interlock bottom edge of roof edge flashing with continuous cleats anchored to substrate at [24-inch (600-mm)] [16-inch (400-mm)] <Insert spacing> centers.

C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.

1. Interlock exterior bottom edge of coping with continuous cleats anchored to substrate at [24-inch (600-mm)] [16-inch (400-mm)] <Insert spacing> centers.
2. Anchor interior leg of coping with screw fasteners and washers at [24-inch (600-mm)] [20-inch (500-mm)] [18-inch (450-mm)] <Insert spacing> centers.

D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for [elastomeric] [butyl] sealant, extending a minimum of 4 inches (100 mm) over base flashing. Install stainless-steel draw band and tighten.

E. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with [elastomeric] [butyl] sealant.

1. Secure in a waterproof manner by means of [snap-in installation and sealant or lead wedges and sealant] [interlocking folded seam or blind rivets and sealant] [anchor and washer at 36-inch (900-mm) centers].

F. Roof-Penetration Flashing: Coordinate installation of roof-penetration flashing with installation of roofing and other items penetrating roof. Install flashing as follows:

1. Turn lead flashing down inside vent piping, being careful not to block vent piping with flashing.
2. Seal with [elastomeric] [butyl] sealant and clamp flashing to pipes penetrating roof except for lead flashing on vent piping.

3.5 WALL FLASHING INSTALLATION

A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.

B. Through-Wall Flashing: Installation of [manufactured] [formed] through-wall flashing is specified in Division 4 Section "[Unit Masonry Assemblies] [Stone Veneer Assemblies]."

C. Reglets: Installation of reglets is specified in Division [3 Section "Cast-in-Place Concrete] [4 Section "Unit Masonry Assemblies]."

D. Openings Flashing in Frame Construction: Install continuous head, sill,[jamb,] and similar flashings to extend [4 inches (100 mm)] <Insert extension> beyond wall openings.

3.6 MISCELLANEOUS FLASHING INSTALLATION

A. Overhead-Piping Safety Pans: Suspend pans from pipe and install drain line to plumbing waste or drain line.

B. Equipment Support Flashing: Coordinate installation of equipment support flashing with installation of roofing and equipment. Weld or seal flashing with [elastomeric] [butyl] sealant to equipment support member.

3.7 CLEANING AND PROTECTION

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder and sealants.

C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.

D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:
1. Roof hatches.
2. Equipt curbs

B. Related Sections include the following:
1. Division 6 Section Miscellaneous Carpentry for wood nailers, curbs, and blocking.
2. Division 7 Section "EPDM Roofing” for roofing membrane.
3. Division 7 Section "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
4. Division 7 Section "Joint Sealants" for field-applied sealants.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finish selections.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Standards: Comply with the following:

1. SMACNA's "Architectural Sheet Metal Manual" details for fabrication of units, including flanges and cap flashing to coordinate with type of roofing indicated.
2. NRCA's "Roofing and Waterproofing Manual" details for installing units.

1.5 COORDINATION

A. Verify location and dimensions of roof openings for roof accessories. Coordinate with structural steel and related work by others.

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:

a. Babcock-Davis Hatchways, Inc.
b. Bilco Company.
c. Bristolite Skylights.
d. Dur-Red Products, Inc.
e. J. L. Industries, Inc.
f. Milcor, Inc.
g. Nystrom, Inc.
h. O'Keeffe's Inc.
i. Wasco Products, Inc.

2.2 MATERIALS, GENERAL

A. Galvanized Steel Sheet: ASTM A 653/A 653M with G90 (Z275) coating designation; commercial quality, unless otherwise indicated.

B. Insulation: Manufacturer's standard rigid or semi-rigid glass-fiber board of thickness indicated.

C. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other non-corrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.

D. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

E. Bituminous Coating: SSPC-Paint 12, solvent-type bituminous mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coating.

F. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

G. Elastomeric Sealant: Generic type recommended by unit manufacturer that is compatible with joint surfaces; ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, G, A, and, as applicable to joint substrates indicated, O.

H. Roofing Cement: ASTM D 4586, non-asbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.3 ROOF HATCHES

A. Description:
1. Type: Single-leaf personnel access.
2. Size 30” X 42”
3. Integral-curb and Lid Material: Galvanized steel sheet, 0.079 inch thick.
4. Finish: Prefininished (baked enamel or powder coat.). Manufacturer standard color
5. Construction: Double Wall with gasketed door.
6. Frame: Fabricate units to minimum height of 12 inches with formed cants and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints.
7. Insulation (Lid): Fiberglass, 1-inch thick.
8. Insulation (Curb): Rigid, high-density fiberboard, 1-inch thick.
9. Interior Lid Liner: Manufacturer's standard metal liner of same material and finish as outer metal lid.
10. Sloping Roofs: Where slope or roof deck exceeds 1:48, fabricate hatch curbs with height constant.
11. Hardware: corrosion-resistant or hot-dip galvanized hardware including steel spring latch with turn (interior and exterior) handles, pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.

B. Design Loads:

1. Fabricate hatch to withstand a minimum **40-lbf/sq. ft**. external live load and **50-lbf/sq. ft.** uplift.

C. Safety Railing System: Manufacturer's standard complete system including rails, clamps, fasteners, safety barrier at railing opening, and all accessories required for a complete installation complying with OSHA CFR 29 1910.23 and 1910.27, including the following:
1. Test Load: As required by authorities having jurisdiction.
2. Height: 42 inches above finished roof deck.
3. Pipe or Tube: 1-1/4-inch ID galvanized pipe or 1-5/8-inch OD galvanized tube.
4. Self-Latching Gate: Fabricated of same materials and rail spacing as safety railing system. Provide manufacturer's standard hinges and self-latching mechanism.
5. Pipe Ends and Tops: Covered or plugged with weather-resistant material.
6. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.
7. Fabricate joints that will be exposed to weather in a watertight manner.
8. Close exposed ends of handrail and railing members with prefabricated end fittings.
9. Fasteners: Manufacturer's standard.

2.4 EXPANSION JOINT COVERS

A. Metal-Flanged, Bellows-Type Roof Expansion Assemblies: Provide bellows type as indicated on the drawings with aluminum flanges and Neoprene bellows providing a continuous weather type barrier. Provide manufacturer's standard assemblies of sizes and types indicated, with prefabricated units for corner and joint intersections and horizontal and vertical transitions including those to other building expansion joints, splicing units, adhesives, coatings, and other components as recommended by roof expansion assembly manufacturer for complete installation. Fabricate assemblies specifically for roof-to-roof, roof-to-wall, curb-to-curb, and curb-to-wall applications.

B. Provide assemblies consisting of exposed polymeric sheet over foam bellows, securely anchored at both edges to 3- to 4-inch- wide sheet metal nailing flanges, either flat or angle formed to fit cant or curbs as required. Insulate bellows with closed-cell, flexible rubber or plastic foam not less than 5/16 inch thick; adhere bellows to underside of polymeric sheet.

C. Manufacturers: Subject to compliance with requirements, provide products by one of the following (or approved equal):
   1. Architectural Art Manufacturing, Inc
   2. Balco, Inc.
   3. C/S Group
   4. MM Systems
   5. Michael Rizza Company

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.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 GALVANIZED STEEL SHEET FINISHES

A. Surface Preparation: Clean surfaces with non-petroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.

   1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

B. Factory applied Powder Coat finish color as selected from manufacturers standard range

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

A. General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures.

B. Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual," unless otherwise indicated,

C. Install roof accessories to fit substrates and to result in watertight performance.

D. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.

E. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, **,** including pressure treated lumber, protect against galvanic action 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.
2. Underlayment: Where installing exposed-to-view components of roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene underlayment.
3. Bed flanges in thick coat of asphalt roofing cement where required by roof accessory manufacturers for waterproof performance.

F. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

G. Cap Flashing: Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counterflashing). Seal overlap with thick bead of mastic sealant.

H. Seal joints with elastomeric sealant as required by manufacturer of roof accessories.

3.3 ROOF HATCH INSTALLATION:

A. Coordinate installation with ladder and safety post

B. Check roof hatch for proper operation. Adjust operating mechanism as required. Clean and lubricate joints and hardware.

C. Attach safety railing system to roof hatch curb.

3.4 EXPANSION JOINT COVERS INSTALLATION:

A. Comply with manufacturer's written instructions for handling and installing roof expansion assemblies and materials unless more stringent requirements are indicated. Coordinate installation of roof expansion assembly materials and associated work so complete assemblies comply with assembly performance requirements.

B. Extend roof expansion assemblies over curbs, parapets, and other elements in the construction profile, with factory-fabricated intersections and transitions to provide continuous, uninterrupted, waterproof roof expansion assemblies.

C. On single-ply roofing, install roof expansion assemblies complying with manufacturer's written instructions. Anchor to cants or curbs and seal to membrane with sealant compatible with roofing membrane and roof expansion assembly. Cover flanges with stripping or flashing and install according to roof manufacturers requirements and Roofing Specifications

D. Splice roof expansion assemblies with materials provided by roof expansion assembly manufacturer for this purpose, according to manufacturer's written instructions, to provide continuous, uninterrupted, waterproof roof expansion assemblies.

E. Provide uniform profile of roof expansion assembly throughout length of each installation; do not stretch polymeric sheets.

F. Install mineral-fiber blanket insulation to fill joint space within joint and moisture barrier.

G. Bed anchorage flanges in cement or sealant recommended by manufacturer and securely nail to curbs and cant strips as recommended by manufacturer but not less than 6 inches (150 mm) o.c.

3.5 TOUCH UP, CLEANING AND PROTECTION

A. Touch up damaged metal coatings. Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

B. Clean exposed surfaces according to manufacturer's written instructions.

END OF SECTION 077200

SECTION 078413
FIRE PROTECTION, HVAC & PLUMBING PENETRATION FIRESTOPPING
TABLE OF CONTENTS

SECTION 078413 FIRE PROTECTION, HVAC & PLUMBING PENETRATION FIRESTOPPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Section, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

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

B. Section includes:

1. Through-penetration firestopping in fire rated construction.
2. Through-penetration smoke-stopping in smoke partitions.

1.3 REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory

a. Through-penetration firestop devices (XHCR)
b. Fire resistance rating (BXUV)
c. Through-penetration firestop systems (XHEZ)
d. Fill, void, or cavity material (XHHW)

B. American Society for Testing and Materials Standards:

1. ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time-rated fire walls, smoke barrier walls, time-rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other sections and may or may not be required.

1.5 SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations.
2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations.

1.6 SUBMITTALS

A. Submit in accordance with Division 01 Section *Submittal Procedures*, unless otherwise indicated.

B. Product data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.

C. Shop drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.
2. Manufacturer or manufacturer's representative shall provide qualified engineering judgment and drawings relating to non-standard applications as needed.

D. Quality control submittals:

1. Statement of qualifications.

E. Applicators' qualifications statement:

1. List past projects indicating required experience.

F. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.7 QUALITY ASSURANCE

A. Installer's qualifications: Fire experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
2. At least 2 years experience with systems.
3. Successfully completed at least 5 comparable scale projects using this system.

B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9 PROJECT CONDITIONS

A. Existing condition:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.
2. Furnish forced air ventilation during installation if required by manufacturer.
3. Keep flammable materials away from sparks or flame.
4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

1.10 WARRANTY

A. Submit copies of written warranty agreeing to repair or replace joint sealers which fail in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The warranty period shall be two (2) years from date of substantial completion unless otherwise noted.

1.11 ALTERNATES

A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

PART 2 PRODUCTS

2.1 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.
2. Acceptable manufacturers and products.

a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the System and Applications Schedule

in Part 3.6 of this section.

3. All firestopping products must be from a single manufacturer. All trades shall use products from the same manufacturer unless otherwise noted.

2.2 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in The Systems and Applications Schedule in Part 3.6 of this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.3 ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.

B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
2. Do not proceed until unsatisfactory conditions have been corrected.

B. Coordinate an inspection of all Mechanical Firestopping systems with the Fire Marshal prior to installation of ceilings, walls, etc.

3.2 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire

Resistance Directory and in accordance with manufacturer's instruction.

B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

C. Protect materials from damage on surfaces subject to traffic.

D. When large openings are created in walls or floors to permit installation of pipes, ducts, or other items, close unused portions of opening with firestopping materials tested for the application. See UL Fire Resistance Directory or Section 3.6 of this document.

E. Install smoke stopping as specified for firestopping.

3.4 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.5 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.6 SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1-inch& 2-inch Wide CAJ1009 2000, 2000+, 2003 CAJ1010 2000, 2000+, 2003 CAJ1012 2000, 2000+, 2003 CAJ1013 2000, 2000+, 2003 CAJ1014 2000, 2000+, 2003 CAJ1015 2000, 2000+, 2003 CAJ1017 FD 150 CAJ1021 FD 150 CAJ1027 MPS-2+ CAJ1044 CP 25WB+ CAJ1052 CP 25S/L, CP 25N/S CAJ1058 2000, 2000+, 2003 CAJ1060 2000, 2000+, 2003 CAJ1063 2000, 2000+, 2003 CAJ1066 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1091 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1092 CP 25WB+ CAJ1112 FS-195+ CAJ1160 CP 25S/L, CP 25N/S CAJ1175 CP 25WB+ CAJ1176 CP 25WB+ CAJ1188 2000+ CBJ1020 CS-195+, FS-195+ CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001 FA1002 CP 25WB+ WJ1010 CP25WB+ WJ1023 2001	WL1001 CP 25 WL1002 FS-195+ WL1003 CP 25WB+,CP 25N/S WL1008 2000+ WL1009 2000+ WL1010 2000+ WL1016 CP 25WB+ WL1017 CP 25WB+,CP 25N/S WL1032 CP 25WB+,CP 25N/S WL1036 FD 150 WL1037 CS-195+,FS-195+ WL1067 CP 25N/S WL1073 CP 25WB+ WL1080 MPS2+ WL1082 2000+	FC1002 CP 25 FC1003 2000,2000+,20003 FC1006 CP 25WB+
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195 CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CAJ2177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+, PPD'S FA2011 FS-195+ WJ2012 FS-195+ 1-inch WIDE	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+ 4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ 1-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195 FC2026 FS-195+ FC2028 FS-195, 1' & 2-inch WIDE, PPD'S

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Insulated Metallic Pipe	CAJ5001 CP 25N/S, CP 25S/L, CP 25WB+ CAJ5002 FS-195+ CAJ5003 FS-195+ CAJ5005 MPS-2+ CAJ5009 2000+, 2003 CAJ5017 FS-195+, CP 25 CAJ5022 FS-195+ CAJ5024 FS-195+ CAJ5030 CS-195+, FS-195+ CAJ5041 2000, 2000+, 2003 CAJ5060 CP 25WB+ CAJ5074 2000+ CBJ5002 CP 25 CBJ5003 FS-195+ FA5001 FS-195+, CP 25WB+	WL5001 FS-195+ WL5002 FS-195+ WL5009 FS-195+ WL5010 FS-195+ WL5011 CP 25WB+ WL5032 2000+ WL5038 CP 25WB+ WL5039 CP 25WB+ WL5040 CP 25WB+ WL5045 CP 25WB+ WL5053 2000+	FC5002 FS-195+ FC5008 FS-195+
Miscellaneous Mechanical HVAC Ducts	CAJ7001 CP 25N/S CP 25S/L CAJ7003 CP 25WB+ CAJ7009 DUCT WRAP, BULK PUTTY		FC7001 CP 25S/L, CP 25N/S
Mixed Penetrating Items Combos	CAJ8001 CS-195+ FS-195 CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+ CBJ8005 CS-195+, MPS-2+ CBJ8008 2001 FA8001 FS-195+, CP 25WB+	WL8002 CS-195+, FS-195+	

* Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION

SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes joint sealants for the applications indicated in the Joint-Sealant Schedule at the end of Part 3.

B. This Section includes joint sealants for the following applications:

1. Exterior joints in the following vertical surfaces and horizontal non-traffic surfaces:
   a. Control and expansion joints in unit masonry.
   b. Joints in exterior insulation and finish systems.
   c. Joints between metal panels.
   d. Joints between different materials.
   e. Perimeter joints between materials listed above and frames of [new] exterior doors, windows, and louvers.
   f. Perimeter and Control and expansion joints in soffits.
   g. Other joints as indicated.

2. Exterior joints in the following horizontal traffic surfaces:
   a. Isolation and contraction joints in cast-in-place concrete slabs, including pavement, sidewalks and equipment pads.
   b. Other joints as indicated.

3. Interior joints in the following vertical surfaces and horizontal non-traffic surfaces:

   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Interior perimeter of exterior openings where indicated.
   c. Tile control and expansion joints.
   d. Vertical joints on exposed surfaces of partitions.
   e. Perimeter joints between interior wall surfaces and frames of new interior doors and windows.
   f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
   g. Plastic laminate countertop backsplashes to vertical surfaces.
   h. Perimeter ceiling grid molding to vertical surfaces.
   i. Where dissimilar material abut and no trim is indicated to conceal joint

j. Other joints as indicated.

4. Interior joints in the following horizontal traffic surfaces:

   a. Isolation joints in cast-in-place concrete slabs.
   b. Control and expansion joints in tile flooring.
   c. Other joints as indicated.

C. Related Sections include the following:

1. Division 4 Section "Unit Masonry Assemblies" for masonry control and expansion joint fillers and gaskets.
2. Division 7 Section "Fire Stop Systems" for sealing joints in fire-resistance-rated construction.
3. Division 8 Section "Glazing" for glazing sealants.
4. Division 9 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.
5. Division 9 Section "Ceramic Tile" for sealing tile joints.
6. Division 9 Section "Acoustical Panel Ceilings" and "Acoustical Tile Ceilings" for sealing edge moldings at perimeters of acoustical ceilings.

1.3 PERFORMANCE REQUIREMENTS

A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. 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.

D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.

E. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.

F. Qualification Data: For Installer of exterior sealant systems.

G. Preconstruction Field Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on preconstruction testing specified in "Quality Assurance" Article.

H. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

I. Field Test Report Log: For each exterior elastomeric sealant application.

J. Product Test Reports: Based on comprehensive testing of product formulations performed by a qualified testing agency, indicating that sealants comply with requirements.

K. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized Installer who is approved or licensed for installation of exterior elastomeric sealants required for this Project.

B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.

C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing of current sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period preceding the “Notice to Proceed with Commencement of” the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in-peel, and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

E. Preconstruction Field-Adhesion Testing: Before installing elastomeric sealants, field test their adhesion to Project joint substrates as follows:

1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
2. Conduct field tests for each application indicated below:

    a. Each type of elastomeric sealant and joint substrate indicated.
    b. Each type of non-elastomeric sealant and joint substrate indicated.

3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.

    a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193.

        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 in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type 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.

F. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:

1. Demonstration Wall Mock Up: Build mockups to demonstrate aesthetic effects and set quality standards for fabrication and installation. Furnish and install components described in this section as necessary for completion of building exterior corner and window installation as described in Section 4810 - UNIT MASONRY ASSEMBLIES. Mock Up to be 6’ wide by 2’ wide X 12’ high representing typical building exterior corner and window installation composed of all masonry types and colors, metal panel, parapet, flashing coping and other exterior wall components. Architect will provide sketch of final mockup configuration.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 PROJECT CONDITIONS

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

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

1.7 WARRANTY

A. Special Installer's Warranty: Installer's standard form in which Installer agrees to repair or replace elastomeric 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 elastomeric sealant manufacturer agrees to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

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

C. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
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 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 MATERIALS, GENERAL

A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.

B. VOC Content of Interior Sealants: Provide interior sealants and sealant primers that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Sealants: 250 g/L.
2. Sealant Primers for Nonporous Substrates: 250 g/L.
3. Sealant Primers for Porous Substrates: 775 g/L.

C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.3 ELASTOMERIC JOINT SEALANTS

A. Elastomeric Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

B. Stain-Test-Response Characteristics: Where elastomeric sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

C. Suitability for Immersion in Liquids. Where elastomeric sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247 and qualify for the length of exposure indicated by reference to ASTM C 920 for Class 1 or 2. Liquid used for testing sealants is deionized water, unless otherwise indicated.

D. Suitability for Contact with Food: Where elastomeric sealants are indicated for joints that will come in repeated contact with food, provide products that comply with 21 CFR 177.2600.

2.4 JOINT-SEALANT BACKING

A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C 1330, Type as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

C. Preformed, compressible, resilient, non-staining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, and shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance closed cell polyethylene foam, nonabsorbent to liquid water and gas, non-outgassing in unruptured state. Size of 30% compression unless otherwise recommended by Manufacturer.

Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

D. 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 where such adhesion would result in sealant failure. 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 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: Non-staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
   a. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, 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.

2. Remove laitance and form-release agents from concrete.

B. Joint Priming: Prime joint substrates, where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.

B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

1. Do not leave gaps between ends of 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 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 configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

G. Installation of Preformed Tapes: Install according to manufacturer's written instructions.

3.4 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.

3.5 PROTECTION

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

3.6 JOINT-SEALANT SCHEDULE

A. Exterior horizontal construction joints in cast-in-place concrete:

Provide one of the following. Multicomponent self-leveling Pourable Urethane Sealant; Type M (multi-component), Grade P (pourable), Class 25, traffic use, per ASTM C-920:

1. Pecora Corporation; Dynatrol II-SG.
2. Tremco THC-900, THC-901
3. Tremco; Vulkem 245, 255
4. Meadows; Pourthane
5. Sika; Sikaflex-2c SL
6. Sonneborn; SL.2

B. Exterior Joints in vertical surfaces, including following locations:
1. Control and expansion joints in unit masonry.
2. Exterior butt joints between metal panels
3. Exterior joints in exterior insulation and finish systems.
4. Exterior joints between different materials in vertical surfaces.
5. Exterior perimeter joints at frames of doors, windows, and/or louvers.
6. Exterior perimeter and expansion joints in soffits

7. TWO PART URETHANE: Provide one of the following Multi-Component (Type M) Urethane, Grade NS (Non-Sag), Class 25.) per ASTM C-920,
   a. Pecora Corporation; Dynatrol II.
   b. Tremco; Dymeric **240-FC** 511
   c. Tremco; Vulkem 922
   d. Sika; 2a NS

8. ONE PART URETHANE: Provide one of the following **Single Component Urethane** (Type S), Grade Non-Sag (NS), Class 25 per ASTM C-920:
   a. Pecora Corporation; Dynatrol I XL.
   b. Tremco; Vulkem 921
   c. Tremco; Vulkem 116 or 931
   d. Sika; 1a
   e. Sonneborn; NP1
   f. Tremco Dymonic

9. ONE PART SILICONE**:** Provide one of the following Low-Modular Silicone Sealant; Type S (single component) Grade NS (non-sag), Class 25 per ASTM C-920:
   1. Dow; 790
   2. GE; Silpruf, or UltraPruf SCS 2900
   3. Tremco; Spectrum 1 or 3.

C. Interior Joints, including the following locations:
1. Vertical control and expansion joints on exposed interior surfaces of exterior masonry walls, unless indicated to receive expansion joint cover.
2. Exposed vertical surfaces of interior unit masonry walls and partitions
3. Exposed vertical joints between unit masonry and dissimilar materials.
4. Perimeter joints at frames of doors, windows, and louvers, etc. in unit masonry.

5. ONE PART URETHANE**:** Provide one of the following Single Component Urethane (Type S), Grade Non-Sag (NS), Class 25.), per ASTM C-920:
   a. Pecora Corporation; Dynatrol I XL.
   b. Tremco; Vulkem 921
   c. Tremco; Vulkem 116 or 931
   d. Sika; 1a
   e. Sonneborn; NP1
   f. Tremco Dymonic

D. Interior joints in damp or wet areas**,** including the following locations:

1. Between plumbing fixtures (including sinks, lavatories, drinking fountains, showers, tubs, etc.) adjoin walls, floors, and counters.
2. Control, perimeter, and expansion joints in ceramic tile.
3. Where backsplashes of countertop with sinks, or in food service areas, abut vertical surfaces.
4. Escutcheon plates, cabinets in toilet rooms or in food service areas.

5. Provide one of the following Single Component mildew-resistant Silicone (Type S), Grade Non-Sag (NS), Class 25 per ASTM C-920:
   a. Pecora Corporation; 898.
   b. Tremco; Tremsill 200
   c. Dow; 786 Mildew Resistant
   d. GE; Sanitary 1700

E. Interior Joints in drywall and gypsum plaster construction, including following locations:
1. Perimeter joints between interior wall surfaces and frames of doors and windows.
2. Vertical joints on exposed surfaces of partitions.
3. Perimeter joints between interior wall surfaces and frames of [new} interior doors and windows.
4. Where backsplashes of countertop without sinks, abut vertical surfaces.
5. Perimeter ceiling grid molding to vertical surfaces.
6. Where dissimilar material abut and no trim is indicated to conceal joint
7. Other joints as indicated.

8. Provide one of the following Acrylic-Emulsion (Latex) Sealant One-part, nonsag, Type 5, Grade NS Class 12.5 mildew-resistant, paintable, complying with ASTM C 834.
   a. Pecora Corporation; AC 20+.
   b. Tremco; Tremflex 834
   c. Approved equal.

F. Joints at metal flashings, at roof accessories**,** and at exterior joints where sliding movement occurs, Provide one of the following Butyl rubber solvent release joint sealan**t.**
   a. Pecora Corporation; BC-158
   b. Tremco; Tremco Butyl Sealant

END OF SECTION 079200

SECTION 081113 –STEEL (HOLLOW METAL) FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Standard hollow metal frames.

B. Related Sections

1. Division 4 Section "Unit Masonry Assemblies" for embedding anchors for hollow metal work into masonry construction.
2. Division 8 Section "Wood Doors” for solid and hollow core doors installed in steel door frames
3. Division 8 Section "Door Hardware"
4. Division 9 Section n Gypsum Drywall assemblies for spot grouting of frames in Gypsum board partitions
5. Division 9 Section(s) Painting for field painting hollow metal doors and frames.
6. Division 16 Sections for electrical connections including conduit and wiring for door controls and operators.

1.3 DEFINITIONS

A. Minimum Thickness: Minimum thickness of base metal without coatings.

B. Standard Hollow Metal Work: Hollow metal work fabricated according to ANSI/SDI A250.8.

C. Custom Hollow Metal Work: Hollow metal work fabricated according to ANSI/NAAMM-HMMA 861.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, fire-resistance rating, temperature-rise ratings, and finishes.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Include the following:

1. Elevations of each door design.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices, and connections.
7. Details of accessories.
8. Details of moldings, removable stops, and glazing.
9. Details of conduit and preparations for power, signal, and control systems.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification:

1. For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches (75 by 125 mm).
2. For the following items, prepared on Samples about [**12 by 12 inches (305 by 305 mm)**] <**Insert size**> 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.

F. Other Action Submittals:

1. 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 door hardware schedule.

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

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of hollow metal door and frame assembly.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.

B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at [**positive pressure**] **as close to neutral pressure as possible** according to **NFPA 252 or UL 10B /UL 10C**

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.

C. Fire-Rated, Borrowed-Light Frame Assemblies: Assemblies complying with NFPA 80 that are listed and labeled, by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to **NFPA 257 or UL 9**. Label each individual glazed lite.

D. Smoke-Control Door Assemblies: Comply with **NFPA 105 or UL 1784**

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

1.6 REFERENCE STANDARDS

A. Steel Door Institute:

1. SDI 100: Recommended Specifications-Standard Steel Doors and Frames
2. SDI 105: Recommended Erection Instructions for Steel Frames.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

1. Provide additional protection to prevent damage to finish of 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 under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch- (102-mm-) high wood blocking. Do not store in a manner that traps excess humidity.

1. Provide minimum 1/4-inch (6-mm) space between each stacked door to permit air circulation.

D. Upon installation, do not allow doors and frames to be exposesd to excessive moisture or other conditions that will be deleterious to hollow metal or finish

1.8 PROJECT CONDITIONS

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

1.9 COORDINATION

A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: :

1. Amweld Building Products, LLC.
2. Ceco Door Products; an Assa Abloy Group company.
3. Curries Company; an Assa Abloy Group company.
4. Mesker Door Inc.
5. Pioneer Industries, Inc.
6. Steelcraft; an Ingersoll-Rand company.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

C. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum **G60 (Z180) or A60 (ZF180)** metallic coating.

D. Stainless Steel: ASTM A 480

E. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z (12G) coating designation; mill phosphatized.

1. For anchors built into exterior walls, 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.

F. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

G. Powder-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.

H. Grout: ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

I. Mineral-Fiber Insulation: ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-development indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

J. Glazing: Comply with requirements in Division 8 Section "Glazing."

K. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.3 STANDARD HOLLOW METAL FRAMES

A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.

B. Interior Frames: Fabricated from cold-rolled steel sheet.

1. Fabricate frames with mitered or coped corners.
2. Fabricate frames as full profile welded unless otherwise indicated.

C. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.4 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 16 gauge thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 16 gauge thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-(9.5-mm-) 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.

B. Floor Anchors: Formed from same material as frames, not less than **14-Gage** and as follows:

1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.

2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch (50-mm) height adjustment. Terminate bottom of frames at finish floor surface

2.5 HOLLOW METAL PANELS

A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.6 STOPS AND MOLDINGS

A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as door face sheet in which they are installed.

B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch (16 mm) high unless otherwise indicated.

C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch (0.8 mm) thick, fabricated from same material as frames in which they are installed.

2.7 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch- (6.4-mm-thick by 25.4-mm-) wide steel.

C. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

2.8 FABRICATION

A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
1. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.

B. 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. Welded Frames: Weld flush face joints continuously; grind, fill, dress, and make smooth, flush, and invisible.
2. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

3. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
4. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.
5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
6. Jamb Anchors: Provide number and spacing of anchors as follows:

    a. Masonry Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

        1) Two anchors per jamb up to 60 inches (1524 mm) high.
        2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
        3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
        4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

    b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

        1) Three anchors per jamb up to 60 inches (1524 mm) high.
        2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
        3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
        4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.
        5) Two anchors per head for frames above 42 inches (1066 mm) wide and mounted in metal-stud partitions.

    c. Compression Type: Not less than two anchors in each jamb.
    d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

7. Door Silencers: Except on weather-stripped doors, 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. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.

D. 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 furnished as specified in Division 8 Section "Door Hardware."

1. Locate hardware as indicated, or if not indicated, according to ANSI/NAAMM-HMMA 861.
2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 16 Sections.

E. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.

1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
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.
4. Provide loose stops and moldings on inside of hollow metal work.
5. Coordinate rabbet width betwe`en fixed and removable stops with type of glazing and type of installation indicated.

2.9 STEEL FINISHES

A. Prime Finish: Apply manufacturer's standard primer immediately after cleaning and pretreating.

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

B. After fabrication, all tool marks and surface imperfections shall be dressed, filled and sanded as required to make all faces and vertical edges smooth, level and free of all irregularities. Products shall then be chemically treated to insure maximum paint adhesion and shall be coated on all exposed surfaces with a rust-inhibitive primer which shall be cured before shipment.

C. Doors and frames shall receive field applied painted finish provided under Section 09900.

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. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.

B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:

1. 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.
2. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
3. 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.
4. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a perpendicular line from head to floor.

C. 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 of size and profile indicated. Comply with HMMA 840.

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-protection-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 glazing 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 plumbness, squareness, 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 are 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.

   a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.

3. Metal-Stud Partitions: Apply drywall setting compound at the frame anchor location before installing the frame and solidly pack mineral-fiber insulation behind frames.
4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.
5. Concrete Walls: Solidly fill space between frames and concrete with grout. Take precautions, including bracing frames, to ensure that frames are not deformed or damaged by grout forces.
6. In-Place Concrete or Masonry Construction: Secure frames in placfe with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
9. 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 (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.
   e. Field joints Where size of hollow metal frames require field joints secure frames apply body putty fill and make smooth, flush, and invisible on exposed faces.

C. Glazing: Comply with installation requirements in Division 8 Section "Glazing" and with hollow metal manufacturer's written instructions.

1. Secure stops 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 (50 mm) o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Repair damage to new and existing doors and frames. Remove corrosion prior to final painting Apply body putty fill and make smooth, flush, and invisible on exposed faces.

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 Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. 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.

END OF SECTION 081113

SECTION 081416- FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:

1. Division 8 Section "Glazing" for glass view panels in flush wood doors.
2. Division 9 Sections Painting for field finishing doors.

1.3 SUBMITTALS

A. Product Data: For each type of door indicated provide manufacturer data indicating compliance with specifications. Include factory-finishing specifications. Include details of core and edge construction, louvers, and trim for openings.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate requirements for veneer matching.
4. Indicate doors to be factory finished and finish requirements.
5. Indicate fire-protection ratings for fire-rated doors.

D. Samples for Initial Selection: For factory-finished doors.

E. 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 full range of color and grain to be expected in the finished work.
2. Corner sections of doors, approximately 8 by 10 inches (200 by 250 mm), with door faces and edges representing actual materials to be used.

    a. Provide samples for each species of veneer and solid lumber required.
    b. Provide samples for each color, texture, and pattern of plastic laminate required.
    c. Finish veneer-faced door samples with same materials proposed for factory-finished doors.

3. Louver blade and frame sections, 6 inches (150 mm) long, for each material and finish specified.
4. Frames for light openings, 6 inches (150 mm) long, for each material, type, and finish required.

F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors from single manufacturer.

B. Quality Standard: In addition to requirements specified, comply with AWI's "Architectural Woodwork Quality Standards Illustrated."

1. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

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. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

D. Preinstallation Conference: Conduct conference at project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in cardboard cartons and wrap bundles of doors in plastic sheeting.

C. Mark each door on top and bottom rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch section.
b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following

1. Algoma Hardwoods, Inc.
2. Eggers Industries.

3. Graham Manufacturing.
4. Mohawk Flush Doors, Inc.
5. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

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

B. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-2
2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware

   a. 5-inch (125-mm) top-rail blocking, in doors indicated to have closers.
   b. 5-inch (125-mm) bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
   c. 5-inch (125-mm) midrail blocking, in doors indicated to have exit devices.

C. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.

1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.

D. Mineral-Core Doors:

1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware

   a. 5-inch (125-mm) top-rail blocking.
   b. 5-inch (125-mm) midrail blocking, in doors indicated to have exit devices.

3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors

1. Grade: Premium, with except Grade A faces allowed
2. Species Maple, stain to match Architect’s sample.

3. Cut: Plain Sliced.
4. Match between Veneer Leaves: Book match.
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
7. Transom Match: Continuous match
8. Exposed Vertical Edges: Same species as faces or a compatible species
9. Core: Particleboard.
10. Construction: Five plies

2.4 LIGHT FRAMES

A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads as follows unless otherwise indicated.

1. Wood Species: Same species as door faces
2. Profile: Manufacturer's standard shape.
3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.

B. Wood-Veneered Beads for Light Openings in Fire-Rated Doors: Manufacturer's standard wood-veneered noncombustible beads matching veneer species of door faces and approved for use in doors of fire-protection rating indicated. Include concealed metal glazing clips where required for opening size and fire-protection rating indicated.

C. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory primed for paint finish; and approved for use in doors of fire-protection rating indicated.

2.5 FABRICATION

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

1. Comply with requirements in NFPA 80 for fire-rated doors.

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.

1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Transom and Side Panels: Fabricate matching panels with same construction, exposed surfaces, and finish as specified for associated doors. Finish bottom edges of transoms and top edges of rabbeted doors same as door stiles.

1. Fabricate door and transom panels with full-width, solid-lumber**,** rabbeted, meeting rails. Provide factory-installed spring bolts for concealed attachment into jambs of metal door frames.

D. Openings: Cut and trim openings through doors in factory.

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 Division 8 Section "Glazing."
3. Louvers: Factory install louvers in prepared openings.

2.6 FACTORY FINISHING

A. General: Comply with referenced quality standard for factory finishing. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.

1. Finish faces, all four edges, edges of cutouts, and mortises. Stains and fillers may be omitted on edges of cutouts, and mortises**.** Finish top and bottom edges.

B. Finish doors at factory.

C. Finish doors at factory that are indicated to receive transparent finish. Field finish doors indicated to receive opaque finish.

D. Finish doors at factory where indicated in schedules or on Drawings as factory finished.

E. Transparent Finish:

1. Grade: Premium
2. Finish: AWI conversion varnish or catalyzed polyurethane system.
3. Staining: Match Architect's sample
4. Sheen: Satin

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
2. Reject doors with defects.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Hardware: For installation, see Division 8 Section "Door Hardware."

B. Installation Instructions: Install doors to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.

1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.

C. Job-Fitted Doors: Align and fit doors in frames with uniform clearances and bevels as indicated below; do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors. Machine doors for hardware. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.

1. Clearances: Provide 1/8 inch (3.2 mm) at heads, jambs, and between pairs of doors. Provide 1/8 inch (3.2 mm) from bottom of door to top of decorative floor finish or covering unless otherwise indicated. Where threshold is shown or scheduled, provide 1/4 inch (6.4 mm) from bottom of door to top of threshold unless otherwise indicated.

a. Comply with NFPA 80 for fire-rated doors.

2. Bevel non-fire-rated doors 1/8 inch in 2 inches (3-1/2 degrees) at lock and hinge edges.
3. 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.

D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

1. Seal bottom or top edges if modified in field.

3.3 ADJUSTING AND PROTECTION

A. Protect doors as recommended by door manufacturer to assure that wood doors will be without damage or deterioration prior to substantial completion.

B. Operation: Rehang or replace doors that do not swing or operate freely.

C. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION 081416

SECTION 083113 – ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 REQUIREMENTS

A. Provide and install access panels as required or shown on the drawings. Unless otherwise indicated, all access panels shown on architectural series drawings (A-series) are to be furnished and installed by substrate contractor (mason, gypsum drywall, plaster, etc.). Additional access panels required by and/or indicated on Mechanical, Plumbing, Electrical, etc., drawings are to be furnished and installed by that respective contractor. It is the responsibility of the Contractor furnishing the access panel to coordinate type with requirements for fire rating, wall type and thickness and wall finish.

B. Source Limitations: All trades shall obtain each type of access door(s) and frame(s) through one source from a single manufacturer.

1.3 SUMMARY

A. This Section includes the following types of access doors:

1. Wall access doors.
2. Ceiling access doors.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 4 Sections for building in anchors and grouting frames set in masonry construction.
2. Division 7 Section "Roof Accessories" for roof hatches.
3. Division 8 Section "Door Hardware" for mortise or rim cylinder locks.
4. Division 9 Section "Gypsum Board Assemblies" for gypsum board walls and ceilings.
5. Division 9 Section "Tile" for ceramic tile walls.
6. Division 9 Section "Acoustical Tile Ceilings" for access tile in suspended or furred fcacoustical tile ceilings.
7. Division 15 and 16 Section for access doors related to HVAC, Plumbing or Electrical work.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of Contract and Division 1 Specification Sections.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Product data for each type of access door assembly specified, including details of construction relative to materials, individual components, profiles, finishes, and fire-protection ratings (if required).

1. Include complete schedule, including types, general locations, sizes, wall and ceiling construction details, latching or locking provisions, and other data pertinent to installation.

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain access doors for entire Project from one source and by a single manufacturer.

B. Fire-Rated Door Assemblies: Units that comply with NFPA 80, are identical to door and frame assemblies tested for fire-test-response characteristics per test method as indicated below, and are labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.

1. Test Method for Vertical Installations: ASTM E 152.
2. Test Method for Horizontal Installations: ASTM E 119.

1.6 COORDINATION

A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment, and indicate on schedule specified under "Submittals" Article.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. J.L. Industries.
2. Karp Associates, Inc.
3. Larsen's Manufacturing Co.
4. Meadowcraft, Inc.
5. Milcor, Inc., Model M and DW specified.
6. Nystrom, Inc.

2.2 MATERIALS

Steel Sheet: ASTM A 366/A 366M commercial-quality, cold-rolled steel sheet with baked-on, rust-inhibitive primer.

2.3 WALL AND CEILING ACCESS DOORS

1. For Masonry Walls and Concealed Locations: Flush Access Doors with Exposed Trim Units consisting of frame with exposed trim, door, hardware, and complying with the following requirements:

   a. . Application: Exposed masonry, concealed gypsum board areas, ceramic tile.
   b. Frame: 0.0598-inch- (1.52-mm-) thick steel sheet.
   c. Door: 0.0747-inch- (1.90-mm-) thick steel sheet.
   d. Trim: Flange integral with frame, 3/4 inch (19 mm) wide, overlapping surrounding finished surface.
   e. Hinge: Continuous type.
   f. Locks: Flush, screwdriver-operated cam.

2. For Gypsum Board Exposed to View**:** Trimless, Flush Access Doors: Units consisting of frame, concealed edge trim, door, hardware, and complying with the following requirements:

   a. Frame: 0.0598-inch- (1.52-mm-) thick steel sheet.
   b. Door: 0.0747-inch- (1.90-mm-) thick steel sheet.
   c. Concealed, Gypsum Board Edge Trim: 0.0299-inch (0.76-mm) zinc-coated or galvanized-steel sheet with face flange formed to receive joint compound.
   d. Hinge: Concealed spring pin or continuous type.
   e. Locks: Screwdriver-operated cam.

4. Fabrication

   a. General: Manufacture each access door assembly as an integral unit ready for installation.
   b. Steel Access Doors and Frames: Continuous welded construction. Grind welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
   c. Exposed Flange: Nominal 1 to 1-1/2 inches (25.4 to 38.1 mm) wide around perimeter of frame.
   d. For gypsum board assemblies or gypsum veneer plaster, furnish frames with tapable edge trim for gypsum board or gypsum base.
   e. For full-bed plaster applications, furnish frames with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.

f. For installation in masonry construction, furnish frames with adjustable metal masonry anchors.

PART 3 - EXECUTION

3.1 PREPARATION

A. Advise Installers of other work about specific requirements relating to access door installation, including sizes of openings to receive access door and frame, as well as locations of supports, inserts, and anchoring devices. Furnish inserts and anchoring devices for access doors that must be built into other construction. Coordinate delivery with other work to avoid delay.

3.2 INSTALLATION

A. Comply with manufacturer's instructions for installing access doors.
B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finished surfaces.
C. Install concealed-frame access doors flush with adjacent finish surfaces.
D. Do not locate or install access panels in wood or fabric wall panels without prior approval of archttect

3.3 ADJUST AND CLEAN

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

END OF SECTION 083113

SECTION 083613 - SECTIONAL DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section includes electrically operated sectional glazed aluminum doors.

B. Related Sections:

1. Section 055000 "Metal Fabrications" for miscellaneous steel supports.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance: Sectional doors shall meet performance requirements specified without failure due to defective manufacture, fabrication, installation, or other defects in construction and without requiring temporary installation of reinforcing components.

B. Delegated Design: Design sectional doors, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Structural Performance: Exterior sectional doors shall withstand the effects of gravity loads, and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Wind Loads: As indicated on Drawings.

2. Deflection Limits: Design sectional doors to withstand design wind loads without evidencing permanent deformation or disengagement of door components. Deflection of door in horizontal position (open) shall not exceed 1/120 of the door width.

D. Air Infiltration: Maximum rate not more than indicated when tested according to ASTM E 283.

1. Air Infiltration: Maximum rate of 0.08 cfm/sq. ft. (0.406 L/s per sq. m) at 15 and 25 mph (24.1 and 40.2 km/h).

E. Windborne-Debris-Impact-Resistance Performance: Provide glazed sectional doors that pass large-missile-impact and cyclic-pressure tests when tested according to ASTM E 1886 and ASTM E 1996.

F. Seismic Performance: Sectional doors shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

G. Operation Cycles: Provide sectional door components and operators capable of operating for not less than number of cycles indicated for each door. One operation cycle is complete when a door is opened from the closed position to the fully open position and returned to the closed position.

1.4 ACTION SUBMITTALS

A. Product Data: For each type and size of sectional door and accessory. Include the following:

1. Construction details, material descriptions, dimensions of individual components, profile door sections, and finishes.
2. Rated capacities, operating characteristics, electrical characteristics, and furnished accessories.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Samples for Initial Selection: Manufacturer's finish charts showing full range of colors and textures available for units with factory-applied finishes.

1. Include similar Samples of accessories involving color selection.

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

1. Detail fabrication and assembly of seismic restraints.
2. Summary of forces and loads on walls and jambs.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

B. Seismic Qualification Certificates: For sectional doors**,** accessories, and components, from manufacturer.

C. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sectional doors to include in maintenance manuals.

1.7 QUALITY ASSURANCE

A. Wood Door Manufacturer Qualifications: A qualified manufacturer that is certified for chain of custody by an FSC-accredited certification body.

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

C. Source Limitations: Obtain sectional doors from single source from single manufacturer.

1. Obtain operators and controls from sectional door 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. Standard for Sectional Doors: Fabricate sectional doors to comply with DASMA 102 unless otherwise indicated.

F. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and CC/ANSI A117.1.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which 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. Faulty operation of hardware.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use; rust through.
d. Delamination of exterior or interior facing materials.

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

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that show evidence of deterioration of factory-applied finishes within specified warranty period.

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

PART 2 - PRODUCTS

2.1 ALUMINUM DOOR SECTIONS

A. Sections: Construct door sections with stiles and rails formed from extruded-aluminum shapes, complying with ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, with wall thickness not less than 0.065 inch (1.7 mm) for door section 1-3/4 inches (44 mm) deep. Fabricate sections with stile and rail dimensions and profiles shown on Drawings. Join stiles and rails by welding or with concealed, 1/4-inch- (6-mm-) minimum diameter, aluminum or nonmagnetic stainless-steel through bolts, full height of door section. Form meeting rails to provide a weathertight-seal joint.

1. Reinforce sections with continuous horizontal and diagonal reinforcement, as required to stiffen door and for wind loading. Ensure that reinforcement does not obstruct vision lites.
2. Provide reinforcement for hardware attachment.

B. Full-Vision Sections: Manufacturer's standard, tubular, aluminum-framed section fully glazed with 6-mm-thick, ¼” tapered glazing set in vinyl, rubber, or neoprene glazing channel and with removable extruded-vinyl or aluminum stops.

2.2 TRACKS, SUPPORTS, AND ACCESSORIES

A. Tracks: Manufacturer's standard, galvanized-steel track system of configuration indicated, sized for door size and weight, designed for lift type indicated and clearances shown on Drawings, and complying with ASTM A 653/A 653M for minimum G60 (Z180) zinc coating. Provide

complete track assembly including brackets, bracing, and reinforcement for rigid support of ball-bearing roller guides for required door type and size. Slot vertical sections of track spaced 2 inches (51 mm) apart for door-drop safety device. Slope tracks at proper angle from vertical or design tracks to ensure tight closure at jambs when door unit is closed.

B. Track Reinforcement and Supports: Galvanized-steel track reinforcement and support members, complying with ASTM A 36/A 36M and ASTM A 123/A 123M. Secure, reinforce, and support tracks as required for door size and weight to provide strength and rigidity without sag, sway, and vibration during opening and closing of doors.

1. Vertical Track Assembly: Track with continuous reinforcing angle attached to track and attached to wall with jamb brackets.
2. Horizontal Track Assembly: Track with continuous reinforcing angle attached to track and supported at points from curve in track to end of track by laterally braced attachments to overhead structural members.

C. Weatherseals: Replaceable, adjustable, continuous, compressible weather-stripping gaskets of flexible vinyl, rubber, or neoprene fitted to bottom and top of sectional door unless otherwise indicated.

2.3 HARDWARE

A. General: Provide heavy-duty, corrosion-resistant hardware, with hot-dip galvanized, stainless-steel, or other corrosion-resistant fasteners, to suit door type.

B. 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, according to manufacturer's written recommendations for door size. 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 not possible. Provide double-end hinges where required, for doors over 16 feet (4.88 m) wide unless otherwise recommended by door manufacturer.

C. Rollers: Heavy-duty rollers with steel ball-bearings in case-hardened steel races, mounted with varying projections to suit slope of track. Extend roller shaft through both hinges where double hinges are required. Provide 3-inch- (76-mm-) diameter roller tires for 3-inch- (76-mm-) wide track and 2-inch- (51-mm-) diameter roller tires for 2-inch- (51-mm-) wide track.

D. Push/Pull Handles: For push-up or emergency-operated doors, provide galvanized-steel lifting handles on each side of door.

2.4 LOCKING DEVICES

A. 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.

B. Locking Device Assembly: Fabricate with cylinder lock, spring-loaded deadbolt, operating handle, cam plate, and adjustable locking bars to engage through slots in tracks.

1. Lock Cylinders: Provide cylinders standard with manufacturer and keyed to building keying system.
2. Keys: Three for each cylinder.

C. Chain Lock Keeper: Suitable for padlock.

D. Safety Interlock Switch: Equip power-operated doors with safety interlock switch to disengage power supply when door is locked.

2.5 COUNTERBALANCE MECHANISM

A. Torsion Spring: Counterbalance mechanism consisting of adjustable-tension torsion springs fabricated from steel-spring wire complying with ASTM A 229/A 229M, mounted on torsion shaft made of steel tube or solid steel. Provide springs designed for number of operation cycles indicated.

B. Weight Counterbalance: Counterbalance mechanism consisting of filled pipe weights that move vertically in a galvanized-steel weight pipe. Connect pipe weights with cable to weight-cable drums mounted on torsion shaft made of steel tube or solid steel.

C. Cable Drums and Shaft for Doors: Cast-aluminum or gray-iron casting cable drums mounted on torsion shaft and grooved to receive door-lifting cables as door is raised. Mount counterbalance mechanism with manufacturer's standard ball-bearing brackets at each end of torsion shaft. Provide one additional midpoint bracket for shafts up to 16 feet (4.88 m) long and two additional brackets at one-third points to support shafts more than 16 feet (4.88 m) long unless closer spacing is recommended by door manufacturer.

D. Cables: Galvanized-steel lifting cables with cable safety factor of at least [**5**] [**7**] to 1.

E. Cable Safety Device: Include a spring-loaded steel or spring-loaded bronze cam mounted to bottom door roller assembly on each side and designed to automatically stop door if either lifting cable breaks.

F. Bracket: Provide anchor support bracket as required to connect stationary end of spring to the wall and to level the shaft and prevent sag.

G. Provide a spring bumper at each horizontal track to cushion door at end of opening operation.

2.6 ELECTRIC DOOR OPERATORS

A. General: Electric door operator assembly of size and capacity recommended and provided by door manufacturer for door and "operation cycles" requirement specified, with electric motor and factory-prewired motor controls, starter, gear-reduction unit, solenoid-operated brake, clutch, remote-control stations, control devices, integral gearing for locking door, and accessories required for proper operation.

1. Comply with NFPA 70.
2. Provide 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.

B. Usage Classification: Electric operator and components capable of operating for not less than number of cycles per hour indicated for each door.

C. Door-Operator Type: Unit consisting of electric motor, gears, pulleys, belts, sprockets, chains, and controls needed to operate door and meet required usage classification.

1. Trolley: Trolley operator mounted to ceiling above and to rear of door in raised position and directly connected to door with drawbar.
2. Jackshaft, Center Mounted: Jackshaft operator mounted on the inside front wall above door and connected to torsion shaft with an adjustable coupling or drive chain.
3. Jackshaft, Side Mounted: Jackshaft operator mounted on the inside front wall on right or left side of door and connected to torsion shaft with an adjustable coupling or drive chain.

D. Electric Motors: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 110513 "Common Motor Requirements for Equipment" unless otherwise indicated.

1. Electrical Characteristics:

a. Phase: Single phase.
b. Volts: 208 V.
c. Hertz: 60.

2. Motor Type and Controller: Reversible motor and controller (disconnect switch) for motor exposure indicated.
3. Motor Size: Minimum size as indicated. If not indicated, large enough 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.
4. Operating Controls, Controllers (Disconnect Switches), Wiring Devices, and Wiring: Manufacturer's standard unless otherwise indicated.
5. Coordinate wiring requirements and electrical characteristics of motors and other electrical devices with building electrical system and each location where installed.
6. Use adjustable motor-mounting bases for belt-driven operators.

E. Limit Switches: Equip each motorized door with adjustable switches interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

F. Obstruction Detection Device: Equip motorized door with indicated external automatic safety sensor capable of protecting full width of door opening. Activation of device immediately stops and reverses downward door travel.

1. Photoelectric Sensor: Manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.

a. Self-Monitoring Type: Designed to interface with door operator control circuit to detect damage to or disconnection of sensor device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.

G. Remote-Control Station: Momentary-contact, three-button control station with push-button controls labeled "Open," "Close," and "Stop."

1. Interior units, full-guarded, surface-mounted, heavy-duty type, with general-purpose NEMA ICS 6, Type 1 enclosure.
2. Exterior units, full-guarded, standard-duty, surface-mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

H. Emergency Manual Operation: Equip each electrically powered door with capability for emergency manual operation. Design manual mechanism so required force for door operation does not exceed 35 lbf (155 N).

I. Emergency Operation Disconnect Device: Equip operator with 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.

J. Motor Removal: Design operator so motor may be removed without disturbing limit-switch adjustment and without affecting emergency manual operation.

K. Audible and Visual Signals: Audible alarm and visual indicator lights in compliance with regulatory requirements for accessibility.

L. Radio-Control System: Consisting of the following:

1. Three-channel universal coaxial receiver to open, close, and stop door; one per operator.
2. Multifunction remote control.
3. Remote antenna and mounting kit.

2.7 DOOR ASSEMBLY Doors 111.1 and 111.2

A. Full-Vision Aluminum Sectional Door: Sectional door formed with hinged sections.

1. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:

a. Overhead Door corporation, Model 511 Series.

B. Operation Cycles: Not less than 10,000.

C. Aluminum Sections: Full vision.

D. Track Configuration: Standard-lift.

E. Weatherseals: Fitted to bottom and top and around entire perimeter of door. Provide combination bottom weatherseal and sensor edge.

F. Roller-Tire Material: Manufacturer's standard.

G. Locking Devices: Equip door with locking device assembly and chain lock keeper.

1. Locking Device Assembly: Single-jamb side Cremone type, both jamb sides locking bars, operable from inside and outside, with cylinders.

H. Counterbalance Type: Manufacturer’s standard.

I. Manual Door Operator: Push-up operation.

J. Electric Door Operator:

1. Usage Classification: Heavy duty, 60 to 90 cycles per hour.
2. Operator Type: Manufacturer’s standard.
3. Motor Exposure: Interior, clean, and dry.
4. Emergency Manual Operation: Push-up.
5. Obstruction-Detection Device: Automatic photoelectric sensor.

    a. Sensor Edge Bulb Color: Black.

6. Remote-Control Station: Interior.

K. Door Finish:

1. Aluminum Finish: Clear anodized.
2. Factory Prime Finish: Manufacturer's standard color.
3. Finish of Interior Facing Material: Match finish of exterior section face.

2.8 GENERAL FINISH REQUIREMENTS

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

B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.9 ALUMINUM FINISHES

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

2.10 STEEL AND GALVANIZED-STEEL FINISHES

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; according to manufacturer's written instructions and as specified.

B. Tracks:

1. Fasten vertical track assembly to opening jambs and framing, 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.
3. Repair galvanized coating on tracks according to ASTM A 780.

C. Accessibility: Install sectional doors, switches, and controls along accessible routes in compliance with regulatory requirements for accessibility.

3.3 STARTUP SERVICES

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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 weathertight fit around entire perimeter.

D. Align and adjust motors, pulleys, belts, sprockets, chains, and controls according to manufacturer's written instructions.

E. Touch-up Painting: Immediately after welding galvanized materials, clean welds and abraded galvanized surfaces and repair galvanizing to comply with ASTM A 780.

3.5 DEMONSTRATION

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

END OF SECTION 083613

SECTION 084113 - ALUMINUM-FRAMED ENTRANCES / STOREFRONTS & DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Exterior and interior storefront framing.
2. Entrance framing
3. Exterior and interior manual-swing aluminum entrance doors.
4. Steel elements clip angles, brackets, and reinforcing for storefront and securing same to abutting construction

B. Related Sections:

1. Division 7 Section "Sealants"
2. Division 8 Section "Glazing" for glass and glazing materials

1.3 DEFINITIONS

A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.

2. Dimensional tolerances of building frame and other adjacent construction.

3. Failure includes the following:

   a. Deflection exceeding specified limits.
   b. Thermal stresses transferring to building structure.
   c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
   d. Noise or vibration created by wind and by thermal and structural movements.
   e. Loosening or weakening of fasteners, attachments, and other components.
   f. Sealant failure.
   g. Failure of operating units.

B. Structural Loads:

1. Wind Loads:

   a. Basic Wind Speed: 90 mph.
   b. Importance Factor: 1.15.
   c. Exposure Category: B.

2. Design Wind Pressure: System shall be designed to withstand the following loads normal to the plane of the wall:

   a. Pressure (Positive and negative) of not less than **19 PSF** at non-corner zones.
   b. Pressure (Positive and negative) of not less than **23 PSF** at corner zones.

C. Deflection of Framing Members:

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

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

1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.

2. When tested at 150 percent of positive and negative wind-load design pressures, systems, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.

3. Test Durations: As required by design wind velocity, but not fewer than 10 seconds.

E. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (300 Pa).

F. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft. (300 Pa).

1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.

G. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

3. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

H. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 58when tested according to AAMA 1503.

I. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.58 Btu/sq. ft. x h x deg F when tested according to AAMA 1503.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.
2. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

D. Engineering Analysis: Provide data indicating compliance with all performance requirements and design criteria indicated.

1. Provide load analysis, design calculations and/or manufacturers design tables, fully demonstrating compliance with lateral design loads as well as gravity loading as applicable. Indicate reinforcing, anchorage and bracing and other supports and engineering analysis.

E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

F. Submit a set of two (2) samples of required aluminum finish, showing extremes of color and appearance, on minimum 4" long extrusions of the alloys to be used for the Work.

1. The right is reserved to require samples of typical fabricated sections, showing joints, exposed fastenings (if any), quality of workmanship, hardware and accessory items, before fabrication of the Work proceeds.

G. Other Action Submittals:

1. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

H. Qualification Data: For qualified Installer.

I. Welding certificates.

J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for aluminum-framed systems, indicating compliance with performance requirements.

K. Maintenance Data: For aluminum-framed systems to include in maintenance manuals.

L. Warranties: Sample of special warranties.

1.6 QUALITY ASSURANCE

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

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

D. Accessible Entrances: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC/ANSI A117.1.

E. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.

F. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including, but not limited to, excessive deflection.

b. Noise or vibration caused by thermal movements.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Adhesive or cohesive sealant failures.
e. Water leakage through fixed glazing and framing areas.
f. Failure of operating components.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Storefront: Basis-of-Design Product and Subject to compliance with requirements, provide Kawneer North America; Series 450 and 451T**,** front set outside glazed, storefront Framing, or comparable product by one of the following:

1. EFCO Corporation 433T
2. Tubelite Inc.
3. United States Aluminum.
4. Vistawall Architectural Products
5. YKK

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209 (ASTM B 209M).
2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221 (ASTM B 221M).
3. Extruded Structural Pipe and Tubes: ASTM B 429.
4. Structural Profiles: ASTM B 308/B 308M.
5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.

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

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

2.3 FRAMING SYSTEMS

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

1. Construction:

a. Exterior Storefront: Thermally improved.
b. Interior and Vestibule Storefront: non-thermally broken.

2. Glazing System: Retained mechanically with gaskets on four sides.

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components. Provide reinforcing as required to achieve design loading indicated.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.

1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
2. Reinforce members as required to receive fastener threads.
3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

D. Attachments, Supports and Bracing: All work and components required for proper installation - but not indicated - shall be the responsibility of the window wall systems installer. Installer shall provide all components, materials and equipment necessary for the complete and operational installation of products and materials described here. Any work, including supports, brackets, anchorage, miscellaneous steel, not indicated on the drawings to be provided by others, shall be the responsibility of the installer.

E. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

F. Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

G. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 8 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
b. Color: Matching structural sealant.

2.5 ENTRANCE DOOR SYSTEMS

A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.

1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch-(3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
2. Door Design: Wide stile; 5-inch nominal width. Kawneer 500 series or equal

a. Bottom rail: not less than 10 inches above floor or ground plane and complying with accessibility requirements.

3. Glazing Stops and Gaskets: Square, snap-on, extruded-aluminum stops and preformed gaskets. Provide nonremovable glazing stops on outside of door.
4. Entrance Door Hardware: As specified in Division 8 Section "Door Hardware."

2.6 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 7 Section "Joint Sealants."

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) 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. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:

1. Profiles that are sharp, straight, and free of defects or deformations.
2. Accurately fitted joints with ends coped or mitered.

3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from exterior.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At exterior doors, provide compression weather stripping at fixed stops.
2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.8 ALUMINUM FINISHES

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

B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

C. Storefront framing: Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class I, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.

2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 7 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 8 Section "Glazing."

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install perimeter joint sealants as specified in Division 7 Section "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
2. Alignment:

    a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
    b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections.

1. Water Spray Test: Before installation of interior finishes has begun, a minimum area of 75 feet (23 m) by 1 story of aluminum-framed systems designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.

B. Repair or remove work if test results and inspections indicate that it does not comply with specified requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

D. Aluminum-framed assemblies will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 ADJUSTING

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

1. For entrance doors accessible to people with disabilities, adjust closers to provide a 3-second closer sweep period for doors to move from a 70-degree open position to 3 inches (75 mm) from the latch, measured to the leading door edge.

END OF SECTION 084113

SECTION 085200 - WOOD WINDOWS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section includes aluminum-clad wood windows.

1.3 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review, discuss, and coordinate the interrelationship of wood windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
3. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
4. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for wood windows.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.

D. Samples: For each exposed product and for each color specified,[2 by 4 inches (50 by 100 mm) in size.

E. Samples for Initial Selection: For units with factory-applied color finishes.

1. Include similar Samples of hardware and accessories involving color selection.

F. Samples for Verification: For wood windows and components required, prepared on Samples of size indicated below:

1. Exposed Finishes: 2 by 4 inches (50 by 100 mm**)**.
2. Exposed Hardware: Full-size units.

G. Product Schedule: For wood windows. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer and Installer.

B. Product Test Reports: For each type of wood window, for tests performed by a qualified testing agency.

C. Field quality-control reports.

D. Sample Warranties: For manufacturer's warranties.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer capable of fabricating wood windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations and who is certified for chain of custody by an FSC-accredited certification body.

B. Vendor Qualifications: A vendor that is certified for chain of custody by an FSC-accredited certification body.

C. Installer Qualifications: An installer acceptable to wood window manufacturer for installation of units required for this Project.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace wood windows that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure to meet performance requirements.
b. Structural failures including excessive deflection, water leakage, and air infiltration.
c. Faulty operation of movable sash and hardware.
d. Deterioration of materials and finishes beyond normal weathering.
e. Failure of insulating glass.

2. Warranty Period:

a. Window: 10 years from date of Substantial Completion.
b. Glazing Units: 20 years from date of Substantial Completion.
c. Aluminum-Cladding Finish: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Marvin Windows and Doors, Clad Ultimate Casement/Awing Collection or approve equivalent. Substitutions must be requested during the bidding process for consideration.

B. Source Limitations: Obtain wood windows from single source from single manufacturer.

2.2 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

1. Window Certification: WDMA certified with label attached to each window.

B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:

1. Minimum Performance Class: CW.
2. Minimum Performance Grade: 50.

C. Sound Transmission Class (STC): Rated for not less than 30 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

D. Outside-Inside Transmission Class (OITC): Rated for not less than 30 OITC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

E. Windborne-Debris Resistance: Capable of resisting impact from windborne debris based on testing glazed windows identical to those specified, according to ASTM E 1886 and testing information in ASTM E 1996 and requirements of authorities having jurisdiction.

2.3 WOOD WINDOWS

A. Operating Types: Provide the following operating types in locations indicated on Drawings:

1. Awning: Project out.
2. Fixed.

B. Certified Wood: Windows shall be certified as "FSC Mixed Credit" according to FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship," and FSC STD-40-004, "FSC Standard for Chain of Custody Certification."

C. Frames and Sashes: Fine-grained wood lumber complying with AAMA/WDMA/CSA 101/I.S.2/A440; kiln dried to a moisture content of not more than 12 percent at time of fabrication; free of visible finger joints, blue stain, knots, pitch pockets, and surface checks larger than 1/32 inch (0.8 mm) deep by 2 inches (51 mm) wide; water-repellent preservative treated.

1. Exterior Finish: Aluminum-clad wood.

   a. Aluminum Finish: Manufacturer's standard fluoropolymer two-coat system with fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight and complying with AAMA 2605.
   b. Exposed Unfinished Wood Surfaces: Pine.
   c. Color: Custom.

2. Interior Finish: Manufacturer's standard color-coated finish.

   a. Exposed Unfinished Wood Surfaces: Manufacturer's standard species.
   b. Color: White.

D. Insulating-Glass Units: See Glazing Section 088000.

E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.

F. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.

1. Exposed Hardware Color and Finish: brushed nickle.

G. Projected Window Hardware:

1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E 405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

    a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.

2. Hinges: Stainless-steel hinges with stainless-steel-reinforced, sliding nylon shoes.
3. Single-Handle Locking System: Operates positive-acting arms that pull sash into locked position. Provide one arm on sashes up to 29 inches (735 mm) tall and two arms on taller sashes.
4. Limit Devices: Manufacturer’s standard limit devices designed to restrict sash opening.

    a. Limit clear opening to **6 inches (150 mm)** for ventilation; with custodial key release.

5. Operator Stud Cover: Matching operator handle finish. Provide in locations where operator handle is removed for controlled access.
6. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 60 inches (1500 mm) above floor; one pole operator and pole hanger per room that has operable windows more than 72 inches (1800 mm) above floor.

H. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.

I. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.

1. Exposed Fasteners: Do not use exposed fasteners to the greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.

2.4 ACCESSORIES

2.5 INSECT SCREENS

A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.

1. Type and Location: Full, inside for project-out sashes.

B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.

1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.

2. Finish for Interior Screens: Baked-on organic coating in color selected by Architect from manufacturer's full range - white.
3. Finish for Exterior Screens: Matching color and finish of cladding.

C. Aluminum Wire Fabric: 18-by-16 (1.1-by-1.3-mm) mesh of 0.011-inch- (0.28-mm-) diameter, coated aluminum wire.

1. Wire-Fabric Finish: Charcoal gray.

2.6 FABRICATION

A. Fabricate wood windows in sizes indicated. Include a complete system for installing and anchoring windows.

B. Glaze wood windows in the factory.

C. Weather strip each operable sash to provide weathertight installation.

D. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.

E. 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. Allow for scribing, trimming, and fitting at Project site.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.

C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E 2112.

B. Install windows level, plumb, square, true to line, without distortion, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.

3.3 ADJUSTING, CLEANING, AND PROTECTION

A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.

B. Clean exposed surfaces immediately after installing windows. Remove excess sealants, glazing materials, dirt, and other substances.

1. Keep protective films and coverings in place until final cleaning.

C. Remove and replace sashes if glass has been broken, chipped, cracked, abraded, or damaged during construction period.

D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085200

SECTION 087100 – DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes commercial door hardware for the following:

1. Swinging doors.
2. Sliding Doors
3. Other doors to the extent indicated.

B. Door hardware includes, but is not necessarily limited to, the following:

1. Mechanical door hardware.
2. Electromechanical door hardware, power supplies, back-ups and surge protection.
3. Automatic operators.
4. Cylinders specified for doors in other sections.

C. Related Sections:

1. Section 06 10 00 – Rough Carpentry
2. Section 06 20 00 – Finish Carpentry
3. Section 08 11 13 – Hollow Metal Doors and Frames
4. Section 08 14 16 – Flush Wood Doors
5. Section 08 41 13 – Aluminum-Framed Entrances and Storefronts.
6. Section 08 81 00 – Glass and Glazing
7. Section 09 90 00 – Painting
8. Section 28 13 00 – Access Control

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

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ICC/IBC - International Building Code.
3. NFPA 70 - National Electrical Code.
4. NFPA 80 - Fire Doors and Windows.
5. NFPA 101 - Life Safety Code.

6. NFPA 105 - Installation of Smoke Door Assemblies.
7. [State Building Codes, Local Amendments].

E. Standards: All hardware specified herein shall comply with the following industry standards:

1. ANSI/BHMA Certified Product Standards - A156 Series
2. UL10C – Positive Pressure Fire Tests of Door Assemblies

1.3 SUBMITTALS

A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.

3. Content: Include the following information:

a. Type, style, function, size, label, hand, and finish of each door hardware item.
b. Manufacturer of each item.
c. Fastenings and other pertinent information.
d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
e. Explanation of abbreviations, symbols, and codes contained in schedule.
f. Mounting locations for door hardware.
g. Door and frame sizes and materials.

4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

D. Proof of Certification: Provide copy of manufacturer(s) official certification or accreditation document indicating proof of status as a qualified and authorized provider of the primary Integrated Wiegand Access Control Products.

E. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.

F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.

G. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.5 COORDINATION

A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to

source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.

C. Door and Frame Preparation: Related Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.6 WARRANTY

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

B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:

1. Structural failures including excessive deflection, cracking, or breakage.
2. Faulty operation of the hardware.
3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
4. Electrical component defects and failures within the systems operation.

C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.

D. Special Warranty Periods:

1. Ten years for mortise locks and latches.
2. Ten years for extra heavy duty cylindrical (bored) locks and latches.
3. Five years for exit hardware.
4. Ten years for manual door closers.
5. Two years for electromechanical door hardware.

1.7 MAINTENANCE SERVICE

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

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

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

1. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:

a. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

2. Products furnished, but not installed, under this Section include the following. Coordinating, purchasing, delivering, and scheduling remain requirements of this Section.

a. Permanent cylinders, cores, and keys to be installed by Owner.

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

2.2 HANGING DEVICES

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

1. Quantity: Provide the following hinge quantity, unless otherwise indicated:

a. Two Hinges: For doors with heights up to 60 inches.
b. Three Hinges: For doors with heights 61 to 90 inches.
c. Four Hinges: For doors with heights 91 to 120 inches.
d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.

2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

a. Widths up to 3’0”: 4-1/2” standard or heavy weight as specified.
b. Sizes from 3’1” to 4’0”: 5” standard or heavy weight as specified.

3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:

a. Exterior Doors: Heavy weight, non-ferrous, ball bearing hinges unless Hardware Sets indicate standard weight.
b. Interior Doors: Standard weight, steel, ball bearing hinges unless Hardware Sets indicate heavy weight.
c. Tornado Resistant Assemblies: At a minimum, provide heavy weight hinges with stainless steel screws used in accordance with and specified as part of a Severe Storm Shelter Opening meeting ICC 500 and FEMA 361.

4. Hinge Options: Comply with the following where indicated in the Hardware Sets or on Drawings:

a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the following applications:

1) Out-swinging exterior doors.
2) Out-swinging access controlled doors.

5. Acceptable Manufacturers:

a. Hager Companies (HA).
b. McKinney Products (MK).
c. Stanley Hardware (ST).

B. Pivots: ANSI/BHMA A156.4, Grade 1, certified pivots provided either center hung or 3/4" offset type complete with top, bottom, and intermediate pivots (offset pivots only) in quantity according to manufacturer's recommendations. Space intermediate pivots equally not less than 25 inches on center apart or not more than 35 inches on center for doors over 121 inches high. Pivot hinges to have oil impregnated bronze bearing in the top pivot and a radial roller and thrust bearing in the bottom pivot with the bottom pivot designed to carry the full weight of the door. Pivots to be UL listed for windstorm where applicable.

1. Acceptable Manufacturers:

a. ABH Manufacturing (AB).
b. Dorma Products (DO).
c. Rixson Door Controls (RF).

2.3 POWER TRANSFER DEVICES

A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.

1. Acceptable Manufacturers:

a. Hager Companies (HA) - ETW-QC (# wires) Option.

b. McKinney Products (MK) - QC (# wires) Option.

B. Provide mortar guard enclosure on steel frames installed at masonry openings for each electrical hinge specified.

2.4 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.

1. Acceptable Manufacturers:

a. McKinney Architectural Hardware (MK).
b. Rockwood Manufacturing (RO).
c. Trimco (TC).

B. Door Push Plates and Pulls: ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, 4-inches wide by 16-inches high, with square corners and beveled edges, secured with exposed screws unless otherwise indicated.
2. Straight Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection from face of door unless otherwise indicated.
3. Offset Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection and offset of 90 degrees unless otherwise indicated.
4. Push Bars: Minimum 1-inch round diameter horizontal push bars with minimum clearance of 2 1/2-inch projection from face of door unless otherwise indicated.
5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.

a. Acceptable Manufacturers:

1) McKinney Architectural Hardware (MK).
2) Rockwood Manufacturing (RO).
3) Trimco (TC).

2.5 CYLINDERS AND KEYING

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

B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.

C. Cylinders: Original manufacturer cylinders complying with the following:

1. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.

D. Keying System: Each type of lock and cylinders to be factory keyed. Conduct specified "Keying Conference" to define and document keying system instructions and requirements. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner. Incorporate decisions made in keying conference, and as follows:

1. Existing System: Master key or grand master key locks to Owner's existing system.

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

1. Top Master Key: One (1)
2. Change Keys per Cylinder: Two (2)
3. Master Keys (per Master Key Group): Two (2)
4. Grand Master Keys (per Grand Master Key Group): Two (2)
5. Construction Control Keys (where required): Two (2)
6. Permanent Control Keys (where required): Two (2)

F. Construction Keying: Provide construction master keyed cylinders or temporary keyed construction cores where specified. Provide construction master keys in quantity as required by project Contractor. Replace construction cores with permanent cores. Furnish permanent cores for installation as directed under specified "Keying Conference".

G. Key Registration List: Provide keying transcript list to Owner's representative in the proper format for importing into key control software.

H. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge.

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

A. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Grade 1 certified cylindrical (bored) locksets furnished in the functions as specified in the Hardware Sets. Lock chassis fabricated of heavy gauge steel, zinc dichromate plated, with through-bolted application. Furnish with solid cast levers, standard 2 3/4” backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt. Locks are to be non-handed and fully field reversible.

1. Acceptable Manufacturers:

    a. Corbin Russwin Hardware (RU) – CL3300 Series.

B. Lock Trim Design: As specified in Hardware Sets.

2.1 INTEGRATED WIEGAND OUTPUT ACCESS CONTROL LOCKING DEVICES

A. Integrated Wiegand Output Cylindrical Locks: Wiegand output ANSI A156.2, Grade 1, Cylindrical Lockset with integrated proximity card reader and request-to-exit signaling in one complete unit. Hard wired, solenoid driven locking/unlocking control of the lever handle trim with 1/2" deadlocking stainless steel latch. Lock is U.L listed and labeled for use on up to 3 hour fire rated openings.

1. Open architecture, hard wired platform supports centralized control of locking units with new or existing Wiegand compatible access control systems. Inside lever handle (request-to-exit) signaling standard with door position (open/closed status) monitoring (via separately connected DPS).
2. Reader supports either HID 125 kHz proximity (up to 39 bits, including Corporate 1000) or 13.56 MHz (2K-32K) iClass® credentials.
3. 12VDC external power supply required for reader and lock, with optional 24VDC operation available with iClass® reader (125 kHz reader is always 12VDC). Fail safe or fail secure options.
4. Installation requires only one cable run from the lock to the access control panel without requirements for additional proprietary lock panel interface boards or modules.
5. Installation to include manufacturer's access control panel interface board or module where required for Wiegand output protocol.

    a. Acceptable Manufacturers:

        1) Corbin Russwin Hardware (RU) - Access 600 - CL33600 RNE1 Series.

2.2 LOCK AND LATCH STRIKES

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

1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.

3. Strikes for Auxiliary Deadlocks: BHMA A156.5.
4. Dustproof Strikes: BHMA A156.16.

2.3 CONVENTIONAL EXIT DEVICES

A. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature.

1. Acceptable Manufacturers:

    a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    b. Sargent Manufacturing (SA) - 80 Series.
    c. Von Duprin (VD) - 35A/98/99 XP Series.

2.4 DOOR CLOSERS

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

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.

2. Standards: Closers to comply with UL-10C and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.

3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1 provisions for door opening force and delayed action closing.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.

    a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
    b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
    c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.

5. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as specified in the door Hardware Sets.

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

1. Acceptable Manufacturers:

a. Corbin Russwin Hardware (RU) - DC8000 Series.
b. LCN Closers (LC) - 4040XP Series.
c. Sargent Manufacturing (SA) - 351 Series.
d. Norton Door Controls (NO) - 7500 Series.

2.5 ARCHITECTURAL TRIM

A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.

2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Metal Protection Plates: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), beveled on four edges (B4E), fabricated from the following.

a. Stainless Steel: 050-inch thick, with countersunk screw holes (CSK).
b. Brass or Bronze: 050-inch thick, with countersunk screw holes (CSK).
c. Laminate Plastic or Acrylic: 1/8-inch thick, with countersunk screw holes (CSK).

4. Fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets.

5. Metal Door Edging: Door protection edging fabricated from a minimum .050-inch thick metal sheet, formed into an angle or "U" cap shapes, surface or mortised mounted onto edge of door. Provide appropriate leg overlap to account for protection plates as required. Height to be as specified in the Hardware Sets.

6. Acceptable Manufacturers:

a. McKinney Architectural Hardware (MK).
b. Rockwood Manufacturing (RO).

c. Trimco (TC).

2.6 DOOR STOPS AND HOLDERS

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

B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.

1. Acceptable Manufacturers:

a. McKinney Architectural Hardware (MK).
b. Rockwood Manufacturing (RO).
c. Trimco (TC).

C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Acceptable Manufacturers:

a. Rixson Door Controls (RF).
b. Rockwood Manufacturing (RO).
c. Sargent Manufacturing (SA).

2.7 ARCHITECTURAL SEALS

A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.

B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.

1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.

C. Fire Labeled Gasketing: :Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.

1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and UBC 7-2, Fire Tests of Door Assemblies.

D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated, based on testing according to ASTM E 1408.

E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.

F. Acceptable Manufacturers:

1. McKinney Weatherstripping Products (MW).
2. Pemko Manufacturing (PE).
3. Reese Enterprises, Inc. (RS).

2.8 ELECTRONIC ACCESSORIES

A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.

1. Acceptable Manufacturers:

a. Securitron Door Controls (SU) - DPS Series.

B. Power Supplies: Provide Nationally Recognized Testing Laboratory Listed 12VDC or 24VDC (field selectable) filtered and regulated power supplies. Include battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.

1. Acceptable Manufacturers:

a. Securitron Door Controls (SU) - BPS 12/24 Series.

2.9 SLIDING DOOR HARDWARE

A. Sliding Door Hardware: Bartels, T-Series 100

1. Door Panel Material: Wood
2. Door Panel Configurations: Single
3. Mounting Style: Wall
4. Wheel Assembly: 3 piece
5. Aluminum Track: Custom length – see drawings
6. Provide 2-piece floor guide
7. Provide Manufacturer’s standard carrying brackets, slow stop, rubber buffer

8. Provide optional wall bracket, decorative end plate, and aluminum valence

B. Sliding Door Lock: FSB North America, ADA compliant sliding door lock.

2.10 FABRICATION

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

2.11 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware.

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

D. Antimicrobial Finishes: Where specified, finishes on locksets, latchsets, exit devices and push/pull trim to incorporate an FDA recognized. Silver Ion, antimicrobial coating (MicroShield™) listed for use on equipment as a suppressant to the growth and spread of a broad range of bacteria, algae, fungus, mold and mildew.

PART 3 - EXECUTION

3.1 EXAMINATION

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

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

3.2 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.

1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:

1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Integrated Wiegand access control products are required to be installed through current members of the ASSA ABLOY "Certified Integrator" (CI) program.

D. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.

E. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

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

3.4 FIELD QUALITY CONTROL

A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

3.5 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to

operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. and provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

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

3.8 DOOR HARDWARE SCHEDULE

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

B. Manufacturer’s Abbreviations:

1. MK - McKinney
2. RF - Rixson
3. RO - Rockwood
4. RU - Corbin Russwin
5. NO - Norton
6. PE – Pemko
7. BA – Bartels
8. FSB – FSB North America

Hardware Schedule

Set: 1.0

Doors: 111.1, 111.2

1	All Hardware	BY OVERHEAD DOOR SUPPLIER		OT

Set: 2.0

Doors: 111.3, 111.4

2	Pivot - Set	147	626	RF
2	Pivot - Intermediate	M19	626	RF
2	Push/Pull Bar Set	BF15847 T1	US32D	RO
2	Concealed Overhead Stop	6-X36	630	RF
2	Door Closer	J7500	689	NO
1	Threshold	2005AT MSES25SS		PE

Notes: ***NEEDS REVIEW*** Perimeter/meeting stile seals by door/frame supplier.

Set: 3.0

Doors: 100.1, 100.2

2	Pivot - Set	147	626	RF
2	Pivot - Intermediate	M19	626	RF
1	Exit Device (concealed vertical rod, exit only)	ED4800 M52	630	RU
1	Exit Device (concealed vertical rod, storeroom)	ED4800 0859	630	RU
1	Rim Cylinder	3000	630	RU
2	Mortise Cylinder	1000 - LENGTH/CAM TO SUIT	630	RU
2	Pull Handle (Offset)	BF158 TB	630	RO
2	Door Closer	J7500	689	NO
2	Door Stop - HD Floor	471	US26D	RO
1	Threshold	2005AT MSES25SS		PE
1	Rain Guard	346C		PE
2	Sweep	3452CNB		PE

Notes: Perimeter/meeting stile seals by door/frame supplier.

Set: 4.0

Doors: 100.3, 100.4, 111.5

2	Pivot - Set	147	626	RF
2	Pivot - Intermediate	M19	626	RF
1	Exit Device (concealed vertical rod, exit only)	ED4800 M52	630	RU

1	Exit Device (concealed vertical rod, storeroom)	ED4800 0859	630	RU
1	Rim Cylinder	3000	630	RU
2	Mortise Cylinder	1000 - LENGTH/CAM TO SUIT	630	RU
2	Pull Handle (Offset)	BF158 TB	630	RO
2	Concealed Overhead Stop	6-X36	630	RF
2	Door Closer	J7500	689	NO
1	Threshold	2005AT MSES25SS		PE
1	Rain Guard	346C		PE
2	Sweep	3452CNB		PE

Notes: Perimeter/meeting stile seals by door/frame supplier.

Set: 5.0

Doors: 101

6	Hinge	TA2714 x NRP 4-1/2" x 4-1/2"	US26D	MK
1	Dust Proof Strike	570	US26D	RO
2	Flush Bolt	555 (or) 557	US26D	RO
1	Cylindrical Lock (storeroom)	CL3357 NZD	626	RU
1	Surface Overhead Stop	10-X36	652	RF
2	Silencer	608 (or) 609	GRY	RO

Set: 6.0

Doors: 107.1

3	Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Cylindrical Lock (storeroom)	CL3357 NZD	626	RU
1	Door Closer	7500	689	NO
1	Kick Plate	K1050 8" 4BE	US32D	RO
1	Door Stop	403 (or) 441CU	US26D	RO
3	Silencer	608 (or) 609	GRY	RO

Set: 7.0

Doors: 102, 103

3	Hinge	TA2714 x NRP 4-1/2" x 4-1/2"	US26D	MK
1	Cylindrical Lock (storeroom)	CL3357 NZD	626	RU
1	Door Closer	CLP7500	689	NO
1	Kick Plate	K1050 8" 4BE	US32D	RO
3	Silencer	608 (or) 609	GRY	RO

Set: 8.0

Doors: 104

3	Hinge	TA2714 x NRP 4-1/2" x 4-1/2"	US26D MK
1	Cylindrical Lock (classroom)	CL3355 NZD	626 RU
1	Surface Overhead Stop	10-X36	652 RF
3	Silencer	608 (or) 609	GRY RO

Set: 9.0

Doors: 105, 106

3	Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D MK
1	Door Pull	BF Y110 TB	US32D RO
1	Push Plate	70G (4 X 20)	630 RO
1	Door Closer	7500	689 NO
1	Mop Plate	K1050 4" 4BE	US32D RO
1	Kick Plate	K1050 8" 4BE	US32D RO
1	Door Stop	403 (or) 441CU	US26D RO
3	Silencer	608 (or) 609	GRY RO

Set: 11.0

Doors: 107A, 107B, 109, 110

5	Hinge (heavy weight)	T4A3786 x NRP 4-1/2" x 4-1/2"	US26D MK
1	Electric Hinge (heavy weight)	T4A3786-QC12 4-1/2" x 4-1/2"	US26D MK
1	Dust Proof Strike	570	US26D RO
2	Flush Bolt	555 (or) 557	US26D RO
1	Integrated Card Reader Lock	CL33605 NZD M812	626 RU
1	Door Closer	PR7500	689 NO
2	Kick Plate	K1050 8" 4BE	US32D RO
2	Door Stop	403 (or) 441CU	US26D RO
2	Silencer	608 (or) 609	GRY RO
1	Frame Harness	QC-C1500	MK
1	Door Harness	QC-C*** - LENGTH TO SUIT	MK
1	Power Supply	BPS-24-1	RU

Notes: Card access.

Set: 12.0

Doors: 107.2

6	Hinge	TA2714 4-1/2" x 4-1/2"	US26D	MK
1	Dust Proof Strike	570	US26D	RO
2	Flush Bolt	555 (or) 557	US26D	RO
1	Cylindrical Lock (classroom)	CL3355 NZD	626	RU
2	Door Stop	403 (or) 441CU	US26D	RO
2	Silencer	608 (or) 609	GRY	RO

Set 13.0

Doors 108.1, 108.2

1. Sliding Door Lock	1147-RA-6204-ESS-B-2 ¾”	US26D	FSB
1. Sliding Door Hardware	T-Series 100	US26D	BA

END OF SECTION 087100

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.
3. Glazed entrances.
4. Interior borrowed lites.
5. Storefront framing.

B. Related Sections include the following:

1. Division 8 Section "Steel Doors and frames "
2. Division 8 Section "Wood Doors"
3. Division 8 Section "Wood Windows"
4. Division 8 Section "Aluminum Framed Entrances and Storefronts"

1.3 DEFINITIONS

A. Manufacturers of Glass Products: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit that contains dehydrated air or a specified gas.

D. Deterioration of Coated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining

and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in metallic coating.

E. Deterioration of Insulating Glass: Failure of hermetic seal under normal use that is attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

F. Deterioration of Laminated Glass: Defects developed from normal use that are attributed to the manufacturing process and not to causes other than glass breakage and practices for maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

1.4 PERFORMANCE REQUIREMENTS

A. General: Provide glazing systems capable of withstanding normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Glass Design: Glass thickness designations indicated are minimums and are for detailing only. Confirm glass thicknesses by analyzing Project loads and in-service conditions. Provide glass lites in the thickness designations indicated for various size openings, but not less than thicknesses and in strengths (annealed or heat treated) required to meet or exceed the following criteria:

1. Glass Thicknesses: Select minimum glass thicknesses to comply with ASTM E 1300, according to the following requirements:

   a. Specified Design Wind Loads: 35 PSI, but not less than wind loads applicable to Project as required by ASCE 7 "Minimum Design Loads for Buildings and Other Structures": Section 6.0 "Wind Loads." Refer to Structural Drawings for design values

   b. Specified Design Snow Loads: Not less than snow loads applicable to Project as required by ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 7.0, "Snow Loads." Refer to Structural Drawings for design values

   c. Probability of Breakage for Vertical Glazing: 8 lites per 1000 for lites set vertically or not more than 15 degrees off vertical and under wind action. Load Duration: **3 seconds**

   d. Maximum Lateral Deflection: For the following types of glass supported on all 4 edges, provide thickness required that limits center deflection at design wind pressure to 1/50 times the short side length or 1 inch (25 mm), whichever is less.

1) For monolithic-glass lites heat treated to resist wind loads.
2) For insulating glass.
3) For laminated-glass lites.

e. Minimum Glass Thickness for Exterior Lites: Not less than ¼ inch.

f. Thickness of Tinted and Heat-Absorbing Glass: Provide the same thickness for each tint color indicated throughout Project.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures acting on glass framing members and glazing components. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

D. Thermal and Optical Performance Properties: Provide glass with performance properties specified based on manufacturer's published test data, as determined according to procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites ¼ inch.
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. Center-of-Glass Values: Based on using LBL-44789 WINDOW 5.0 computer program for the following methodologies:

a. U-Factors: NFRC 100 expressed as Btu/ sq. ft. x h x deg F.
b. Solar Heat Gain Coefficient: NFRC 200.
c. Solar Optical Properties: NFRC 300.

1.5 SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Samples: For the following products, in the form of 12-inch- (300-mm-) square Samples for glass.

1. Each color of tinted float glass.
2. Each type of patterned glass.
3. Coated vision glass.
4. Wired glass.
5. Each type of laminated glass with colored interlayer.
6. Insulating glass for each designation indicated.
7. For each color (except black) of exposed glazing sealant indicated.

D. Glazing Schedule: Use same designations indicated on Drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.

E. Product Certificates: Signed by manufacturers of glass and glazing products certifying that products furnished comply with requirements. For solar-control low-e-coated glass, provide documentation demonstrating that manufacturer of coated glass is certified by coating manufacturer.

F. Qualification Data: For installers.

G. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

H. Product Test Reports: For each of the following types of glazing products:

1. Tinted float glass.
2. Insulating glass.
3. Glazing sealants and gaskets.

I. Warranties: Special warranties specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Glass Sputter-Coated with Solar-Control Low-E Coatings: Where solar-control low-e coatings of a primary glass manufacturer that has established a certified fabricator program is specified, obtain sputter-coated solar-control low-e-coated glass in fabricated units from a manufacturer that is certified by coated-glass manufacturer.

C. Source Limitations for Glazing Accessories: Obtain glazing accessories through one source from a single manufacturer for each product and installation method indicated.

D. Glass Product Testing: Obtain glass test results for product test reports in "Submittals" Article from a qualified testing agency based on testing glass products.

1. Glass Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
2.

E. Glazing for Fire-Rated Door Assemblies: Glazing for assemblies that comply with NFPA 80 and that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252.

F. Safety Glazing Products: Comply with testing requirements in 16 CFR 1201 and, for wired glass, ANSI Z97.1.

1. Subject to compliance with requirements, obtain safety glazing products permanently marked with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction.
2. Where glazing units, including Kind FT glass and laminated glass, are specified in Part 2 articles for glazing lites more than 9 sq. ft. (0.84 sq. m) in exposed surface area of one side, provide glazing products that comply with Category II materials, for lites 9 sq. ft. (0.84 sq. m) or less in exposed surface area of one side, provide glazing products that comply with Category I or II materials, except for hazardous locations where Category II materials are required by 16 CFR 1201 and regulations of authorities having jurisdiction.

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

1. GANA Publications: GANA Laminated Division's "Laminated Glass Design Guide" and and GANA's "Glazing Manual."
2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "Glazing Guidelines for Sealed Insulating Glass Units."

H. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the following testing and inspecting agency: Insulating Glass Certification Council.

I. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

1.8 PROJECT 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 liquid glazing sealants when ambient and substrate temperature conditions are outside limits permitted by glazing sealant manufacturer or below 40 deg F (4.4 deg C).

1.9 WARRANTY

A. Manufacturer's Special Warranty for Glass Products: For each of the listed products, Manufacturer's standard form, made out to Owner and signed by glass manufacturer agreeing to replace units that deteriorate as defined in "Definitions" Article, f.o.b. the nearest shipping point to Project site, within specified warranty period of **10** years from date of Substantial Completion.

1. Coated Glass
2. Laminated Glass
3. Insulating Glass: .

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. Products: Subject to compliance with requirements, provide one of the products specified.
2. Product: Subject to compliance with requirements, provide product specified.
3. 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.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
5. Basis-of-Design Product: The design for each glazing product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 GLASS PRODUCTS

A. Annealed Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.

2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
3. For uncoated glass, comply with requirements for Condition A.
4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
5. Provide Kind FT (fully tempered) float glass in place of annealed or Kind HS (heat-strengthened) float glass where safety glass is indicated.

C. Wired Glass: ASTM C 1036, Type II (patterned and wired flat glass), Class 1 (clear), Quality-Q-6; and of form and mesh pattern specified.

D. Tempered Patterned Glass: ASTM C 1048, Kind FT (fully tempered), Type II (patterned flat glass), Class 1 (clear), Form 3 (patterned); and of quality, finish, and pattern specified.

E. Laminated Glass: ASTM C 1172, and complying with other requirements specified and with the following:

1. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation. Laminate lites in autoclave with heat plus pressure.

2. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets.

F. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.

1. All insulated gals units to be argon gas filled with LowE coating on surface #3, unless noted otherwise.
2. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
3. Provide Kind FT (fully tempered) glass lites where safety glass is indicated or required.
4. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
5. Sealing System: Dual seal, with primary and secondary sealants.\
6. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.3 GLAZING GASKETS

A. Compression Gaskets: Molded or extruded gaskets of material suitable for application and compatible with other materials and sealants used in assembly of storefront and curtainwall framing, and of profile and hardness required to maintain watertight seal:

2.4 GLAZING SEALANTS

A. General: Provide products of type indicated, complying with the following requirements:

1. Compatibility: Select glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Elastomeric Glazing Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

C. Glazing Sealants for Fire-Resistive Glazing Products: Identical to products used in test assemblies to obtain fire-protection rating.

D. Neutral-Curing Silicone Glazing Sealants (Butt glazing):

a. Type and Grade: S (single component) and NS (nonsag).
b. Class: 25.
c. Use Related to Exposure: NT (nontraffic).
d. Uses Related to Glazing Substrates: G, A, and, as applicable to glazing substrates indicated, O.

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based elastomeric tape with a solids content of 100 percent; 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; packaged on rolls with a release paper backing; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; packaged on rolls with release liner protecting adhesive; and complying with AAMA 800 for the following types:

1. Type 1, for glazing applications in which tape acts as the primary sealant.

2. Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers: Elastomeric blocks or continuous extrusions with a Shore, Type A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

2.7 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to glaze openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites in a manner that produces square edges with slight kerfs at junctions with outdoor and indoor faces.

C. Grind smooth and polish exposed glass edges and corners.

2.8 GLASS UNITS TYPES

A. Glass Type 1: 1” Insulated Glass, (¼” + ½” + ¼”).

Outer Lite: ¼” Pilkington Clear Eclipse Advantage Radiant Low-E #2 surface
Air Space: ½” 90% Argon fill
Inner Lite: ¼” Oldcastle Building Envelope SunGlass Low E #3 surface

B. Glass type 2: 1” Insulated Glass, (¼” + ½” + ¼”) tempered

Outer Lite: ¼” Clear, tempered
Air Space: 90% Argon fill
Inner Lite: ¼” Clear, tempered, Low E coating #3 surface

C. Glass Type 3: ¼” clear, tempered glass. Grade B fully tempered, Style 1 (uncoated surface), Type 1 (float), Quality (glazing quality) Class 1 (transparent).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing glazing, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep system.
3. Minimum required face or edge clearances.
4. Effective sealing between joints of glass-framing members.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

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. Glazing channel dimensions, as indicated on Drawings, provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by Project conditions during installation.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm) as follows:

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and

glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.

2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.

E. Do not remove release paper from tape until just before each glazing unit is installed.

F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

G. Apply cap bead of elastomeric sealant over exposed edge of tape at all horizontal aapications and where required.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in 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. 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.

3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels, and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended by glass manufacturer.

C. 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; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 088400 - PLASTIC GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Multiwalled structured polycarbonate glazing.

1.3 PERFORMANCE REQUIREMENTS

A. Provide plastic glazing sheets and glazing materials capable of withstanding normal temperature changes, wind, and impact loads without failure, including loss or breakage of plastic sheets attributable to the following: failure of sealants or gaskets to remain watertight and airtight, deterioration of plastic sheet and glazing materials, or other defects in materials and installation.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on plastic glazing and glazing framing members.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.4 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Test each plastic glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.

1. Testing will not be required if data are submitted based on previous testing of current sealant products and plastic glazing 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 glazing, tape sealants, gaskets, and glazing channel substrates.
3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.

4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

1.5 ACTION SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Plastic Glazing Samples: For each color and finish of plastic glazing indicated, 12 inches (300 mm) square and of same thickness indicated for final Work.

D. Glazing Accessory Samples: For gaskets and sealants, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

E. Plastic Glazing Schedule: List plastic glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of plastic glazing and construction that receives plastic glazing, including clearances and glazing channel dimensions.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For installers.

B. Product Certificates: For plastic glazing and glazing products, from manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for plastic glazing, glazing sealants and glazing gaskets.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.

D. Preconstruction adhesion and compatibility test report.

E. Research/Evaluation Reports: For plastic glazing.

F. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For plastic glazing to include in maintenance manuals.

1.8 QUALITY ASSURANCE

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

B. Source Limitations: Obtain plastic glazing from single source from single manufacturer. Obtain [**sealants**] [**and**] [**gaskets**] from single source from single manufacturer for each product and installation method.

C. Glazing Publication: Comply with published recommendations of plastic glazing manufacturers and with GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glazing terms not otherwise defined in this Section or in other referenced standards.

D. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect plastic glazing materials according to manufacturer's written instructions. Prevent damage to plastic glazing and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Maintain protective coverings on plastic glazing to avoid exposures to abrasive substances, excessive heat, and other sources of possible deterioration.

1.10 PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.11 COORDINATION

A. Coordinate dimensions of plastic glazing with dimensions of construction that receives plastic glazing to ensure that glazing channels provide adequate face and edge clearance, bite, and allowance for expansion.

1.12 WARRANTY

A. Manufacturer's Special Warranty for Abrasion- and UV-Resistant, Multiwalled Structured Polycarbonate: Manufacturer's standard form, made out to Owner and signed by polycarbonate manufacturer, in which manufacturer agrees to replace polycarbonate products that break or develop defects from normal use that are attributable to manufacturing process and not to practices for maintaining and cleaning plastic glazing contrary to manufacturer's written instructions. Defects include coating delamination, haze, excessive yellowing, and loss of light transmission beyond the limits stated in plastic glazing manufacturer's standard form.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLASTIC GLAZING, GENERAL

A. Sizes: Fabricate plastic glazing to sizes required for openings indicated. Allow for thermal expansion and contraction of plastic glazing without restraint and without withdrawal of edges from frames, with edge clearances and tolerances complying with plastic glazing manufacturer's written instructions.

B. Fire-Test-Response Characteristics of Plastic Glazing: As determined by testing plastic glazing by a qualified testing agency acceptable to authorities having jurisdiction.

1. Self-ignition temperature of 650 deg F (343 deg C) or higher when tested according to ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
2. Smoke-developed index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested according to ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
3. Burning extent of 1 inch (25 mm) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work[**, where Class CC1 is indicated**].
4. Burning rate of 2.5 in./min. (1.06 mm/s) or less when tested according to ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work[**, where Class CC2 is indicated**].
5. Flame-spread index not less than that indicated when tested according to ASTM E 84.

2.2 MULTIWALLED STRUCTURED POLYCARBONATE GLAZING

Provide product by Polygal Plastics Industries Ltd., Extech Exterior Technologies or Gallina for the following:

A. Type 1: Polygal Plastics Industries Ltd., Selectogal RFX, 5/8” clear, provide manufacturer’s standard perimeter and joining components. Provide HCP connection profiles at all heads, sills, joints and corners with vent tape and gaskets as required. Type 1 system shall be a decorative rainscreen only installed over an aluminum rainscreen support system.

B. Type 2: Extech Exterior Technologies, Inc., 40 mm (19/16" thick), in clear anodized, thermally broken aluminum frame.

C. Type 3: Polygal Plastics Industries Ltd., Standard 5/8", clear, provide manufacturer's standard perimeter and joining components.

D. Framing System: Provide Rainscreen Support System by North Clad, EF Panel System, or approved equivalent.

2.3 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets, EPDM, ASTM C 864 or silicone, ASTM C 1115; and of profile and hardness required to maintain watertight seal.

B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM or silicone gaskets complying with ASTM C 509, Type II, black; and of profile and hardness required to maintain watertight seal.

2.4 GLAZING SEALANTS

A. General:

1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including plastic glazing products 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. Sealants used inside the weatherproofing system shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
4. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
5. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.

B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.

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

a. Dow Corning Corporation; 790.
b. General Electric Company, GE Advanced Materials - Silicones; SilPruf LM SCS2700.
c. May National Associates, Inc.; Bondaflex Sil 290.
d. Pecora Corporation; 890.

e. Sika Corporation, Construction Products Division; SikaSil-C990.
f. Tremco Incorporated; Spectrem 1.

2.5 GLAZING TAPES

A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:

1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.6 MISCELLANEOUS GLAZING MATERIALS

A. Compatibility: Provide products of material, size, and shape complying with requirements of manufacturers of plastic glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.

C. Setting Blocks: EPDM or silicone as required for compatibility with glazing sealant and plastic glazing, and of hardness recommended by plastic glazing manufacturer for application indicated.

D. Compressible Filler Rods: Closed cell of waterproof-jacketed rod stock of synthetic rubber or plastic foam, flexible and resilient, with 5- to 10-psi (35- to 70-kPa) compression strength for 25 percent deflection.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine plastic glazing framing, with glazing Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Minimum required face or edge clearances.
3. Effective sealing between joints of plastic glazing framing members.

B. Proceed with glazing only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean glazing channels and other framing members immediately before glazing. Remove coatings not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of plastic glazing materials, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publication.

B. Glazing channel dimensions indicated on Drawings are designed to provide the necessary bite on plastic glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances. Adjust plastic glazing lites during installation to ensure that bite is equal on all sides.

C. Sand or scrape cut edges of plastic glazing to provide smooth edges, free of chips and hairline cracks.

D. Remove burrs and other projections from glazing channel surfaces.

E. Protect plastic glazing surfaces from abrasion and other damage during handling and installation, according to the following requirements:

1. Retain plastic glazing manufacturer's protective covering or protect by other methods according to plastic glazing manufacturer's written instructions.
2. Remove covering at border of each piece before glazing; remove remainder of covering immediately after installation where plastic glazing will be exposed to sunlight or where other conditions make later removal difficult.
3. Remove damaged plastic glazing sheets from Project site and legally dispose of off-site. Damaged plastic glazing sheets are those containing imperfections that, when installed, result in weakened glazing and impaired performance and appearance.

F. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction sealant-substrate testing.

G. Install elastomeric setting blocks in sill channels, sized and located to comply with referenced glazing publication, unless otherwise instructed by plastic glazing manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

H. Provide edge blocking to comply with referenced glazing publication unless otherwise instructed by plastic glazing manufacturer.

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 as recommended in writing by gasket manufacturer to prevent corners from pulling away; seal corner and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

A. Install tapes continuously, but not in one continuous length. Do not stretch tapes to make them fit opening.

B. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

C. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant recommended by tape manufacturer.

D. Do not remove release paper from tape until immediately before each lite is installed.

E. Apply heel bead of glazing sealant.

F. Center plastic glazing 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.

G. Apply cap bead of glazing sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

A. Fabricate compression gaskets in lengths recommended in writing by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between plastic glazing and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center plastic glazing 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 plastic glazing. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

A. Install continuous spacers between plastic glazing lites and glazing stops to maintain plastic glazing face clearances and to prevent sealant from extruding into glazing channel weep systems until sealants cure. Secure spacers in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to plastic glazing and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from plastic glazing.

3.7 PROTECTING AND CLEANING

A. Protect plastic glazing from contact with contaminating substances from construction operations. If, despite such protection, contaminating substances do come into contact with plastic glazing, remove immediately and wash plastic glazing according to plastic glazing manufacturer's written instructions.

B. Remove and replace plastic glazing that is broken, chipped, cracked, abraded, or damaged in other ways during construction period, including natural causes, accidents, and vandalism.

C. Wash plastic glazing on both faces before date scheduled for inspections intended to establish date of Substantial Completion in each area of Project. Wash plastic glazing according to plastic glazing manufacturer's written instructions.

END OF SECTION 088400

SECTION 092900 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Interior gypsum wallboard.
2. Exterior gypsum board panels for ceilings and soffits.
3. Non-load-bearing steel framing.
4. Cementitous Backer Unit Gypsum Board
5. Shaft Wall Assemblies

B. Related Sections include the following:

1. Division 5 "Cold-Formed Metal Framing
2. Division 6 "Rough Carpentry
3. Division 7 "Building Insulation
4. Division 9 "Gypsum Sheathing
5. Division 9 "Portland Cement Plaster"

1.3 DEFINITIONS

A. Gypsum Board Terminology: Refer to ASTM C 11 for definitions of terms for gypsum board assemblies not defined in this Section or in other referenced standards.

B. Assembly Performance Requirements

1. Fire Resistance: Provide gypsum board assemblies with fire-resistance ratings indicated.

C. Gypsum board shaft-wall assemblies that comply with the following requirements:

1. They are composed of proprietary gypsum board panels and metal components designed for erection from outside the shafts.

2. They comply with performance requirements specified as determined from testing manufacturers' standard assemblies representing those indicated for this Project.

Coordinate with partition types

D. Structural Performance Characteristics: Engineer, fabricate, and install all gypsum board assemblies to withstand the following lateral design loads (air pressures) without failing and while maintaining an airtight and smoke-tight seal. Apply design loads transiently and cyclically under in-service conditions for maximum heights of partitions indicated. Evidence of failure includes deflections exceeding those indicated below, bending stresses causing studs to break or to distort, and end-reaction shear causing runners to bend or to shear and studs to become crippled.

E. Lateral Design Load: 7.5 psf.

F. Deflection Limit: 1/240 of partition height, except where otherwise indicated.

1.4 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113

1.5 QUALITY ASSURANCE

A. Single-Source Responsibility: Obtain each of the following from a single manufacturer, unless otherwise indicated:

1. Steel framing members for gypsum board assemblies.
2. Gypsum board and other panel products.
3. Proprietary shaftwall assemblies, **including gypsum panel and metal framing**.
4. Finishing materials from either the same manufacturer that supplies gypsum board and other panel products or from a manufacturer acceptable to gypsum board manufacturer.

B. Fire-Test-Response Characteristics: Where fire-resistance-rated gypsum board assemblies are indicated, provide gypsum board assemblies that comply with the following requirements: Products used in the assembly shall carry a classification label from a testing laboratory acceptable to authority having jurisdiction.

C. Fire-Resistance Ratings: As indicated by GA File Numbers in GA-600 "Fire Resistance Design Manual" or design designations in UL "Fire Resistance Directory" or in the listing of another testing and inspecting agency acceptable to authorities having jurisdiction.

D. Gypsum board assemblies indicated are identical to assemblies tested for fire resistance according to ASTM E 119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

E. Deflection and Firestop Track: Top runner provided in fire-resistance-rated assemblies indicated is labeled and listed by UL, Warnock Hersey, or another testing and inspecting agency acceptable to authorities having jurisdiction.

F. Preinstallation Conference: Conduct conference at Project Site to comply with requirements of Division 1 Section "Project Meetings." Meet with Installer, qualified representative of gypsum board shaft-wall manufacturer, and installers of other construction that penetrates, attaches to, or otherwise affects shaft-wall construction.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages, containers, or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials inside under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic, and other causes. Stack gypsum panels flat to prevent sagging.

C. Steel framing and related accessories shall be stored and handled in accordance with the A.I.S.I. “Code of Standard Practice.”

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Room Temperatures: For non-adhesive attachment of gypsum board to framing, maintain not less than 40 deg F. For adhesive attachment and finishing of gypsum board, maintain not less than 50 deg F for 48 hours before application and continuously after until dry. Do not exceed 95 deg F when using temporary heat sources.

C. Ventilation: Ventilate building spaces as required to dry joint treatment materials. Avoid drafts during hot, dry weather to prevent finishing materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Steel Framing and Furring:
   Obsolete manufacturer: Dietrich Industries, Inc.
   MarinoWare; Division of Ware Ind.

2. Gypsum Board and Related Products:
   a. Georgia Pacific Gypsum Corp.
   b. Lafarge Gypsum
   c. National Gypsum Company.
   d. United States Gypsum Co.

2.2 STEEL FRAMING FOR WALLS AND PARTITIONS

A. General: Provide steel framing members complying with the following requirements:

B. Protective Coating: Meeting requirements of ASTM C645-08; roll-formed from hot-dipped galvanized steel; complying with ASTM A1003 and ASTM A653 G40 or equivalent corrosion resistant coating.

C. Steel Studs and Runners: ASTM C 645-08, with flange edges of studs bent back 90 degrees and doubled over to form 3/16-inch- wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 0.0179 inch (25 gage) or members that can show certified third party testing in accordance with ICC – ES – AC86 that meets ASTM C645-08 Section 9.2. unless otherwise indicated.
   a. Subject to compliance with requirements, provide Dietrich UltraSTEEL™ Framing 25 gauge-equivalent.

2. Thickness: .0296 inch or members that can show certified third party testing in accordance with ICC – ES – AC86 that meets ASTM C645-08 Section 9.2. as follows: Subject to compliance with requirements, provide Dietrich UltraSTEEL™ Framing 20 gauge-equivalent.
   a. For head runner, sill runner, jamb, and cripple studs at door and other openings.

   b. In locations to receive cementitious backer units.

   c. Where indicated.

3. Depth: 3-5/8 inches, unless otherwise indicated. Refer to Partition schedule for other sizes (depth) required.

D. Deflection Track: Manufacturer's top runner complying with the requirements of ASTM C 645-08 and with 2-inch- deep flanges.

E. DEFLECTION TRACK (SLOTTED): Manufacturer’s single, 2 ½ inch deep-leg, U-shaped

steel track: punched with vertical slots in both legs.

1. Subject to compliance with requirements, suggested product: Dietrich Metal Framing SLP-TRK® Slotted Deflection Track by Brady Innovations

F. Steel Rigid Furring Channels: ASTM C 645-08, hat shaped, depth and minimum thickness of base (uncoated) metal as follows:

1. Thickness: 0.0179 inch, or members that can show certified third party testing in accordance with ICC – ES – AC86 that meets ASTM C645-08 Section 9.2. unless otherwise indicated.

2. Depth: 7/8 inch.
3. Subject to compliance with requirements, provide Dietrich UltraSTEEL™ **(25 gauge equivalent) (20 gauge equivalent).**

G. Steel Resilient Furring Channels: Manufacturer's standard product designed to reduce sound transmission, fabricated from steel sheet Meeting requirements of ASTM C645-08; roll formed from hot-dipped galvanized steel; complying with ASTM A1003 and ASTM A653 G40 or equivalent corrosion resistant coating to form 1/2-inch- deep channel of the following configuration:

H. Single- or Double-Leg Configuration: Asymmetric-shaped channel with face connected to a single flange by a single-slotted leg (web) or hat-shaped channel, with 1-1/2-inch- wide face connected to flanges by double-slotted or expanded-metal legs (webs).

1. Subject to compliance with requirements, provide Dietrich Metal Framing Single Leg Resilient Channel [RCSD] [RCUR] or Double Leg Resilient – [RCDN] [RCDE] UltraSTEEL™ (25 gauge equivalent) (20 gauge equivalent).

I. Steel Channel Bridging steel, 0.0538-inch minimum thickness of base (uncoated) metal and 1/2-inch- wide flanges, 1-1/2 inches deep, 475 lb/1000 feet unless otherwise indicated.

1. Subject to compliance with requirements, provide one of the following:
2. Dietrich Metal Framing: Spazzer® 9200 Bridging and Bracing Bar
3. U-Channel Assembly: **[3/4 inches] [1-1/2 inches] [2 inches]**
   a.Dietrich Metal Framing; EasyClip™ U-Series™ Clip Angle or equivalent.

J. Fasteners for Metal Framing: ASTM C 1513 Provide fasteners of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel framing and furring members securely to substrates involved; complying with the recommendations of gypsum board manufacturers for applications indicated.

K. Flat Strap and Backing Plate: Sheet for blocking and bracing in length and width indicated:
1. Subject to compliance with requirements, provide Dietrich Metal Framing: Danback™ Fire Treated Wood Backing Plate **[D16F] [D24F]**
2. Galvanized Sheet Steel.

2.3 STEEL FRAMING COMPONENTS FOR SUSPENDED AND FURRED CEILINGS

A. General: Provide components complying with ASTM C 754 for conditions indicated.

B. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated, and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190 conducted by a qualified independent testing agency.

C. Wire Ties: ASTM A 641 (ASTM A 641M), Class 1 zinc coating, soft temper, 0.062 inch (1.6 mm) thick.

D. Channels: ASTM C754, shall be cold-formed from steel0.0538-inch (1.5-mm) minimum thickness of base (uncoated) metal and 1/2-inch- (11.1-mm-) wide flanges, and as follows:

1. Carrying Channels: 1-1/2 inches (38.1 mm) deep, 475 lb/1000 feet (70 kg/100 m), unless otherwise indicated.

2. Furring Channels: 3/4 inch (19.1 mm) deep, 300 lb/1000 feet (45 kg/100 m), unless otherwise indicated.

   a. Subject to compliance with requirements, provide Dietrich UltraSTEEL™ **(25 gauge equivalent) (20 gauge equivalent).**

3. Finish: Meeting requirements of ASTM C645-08; C-channel, roll-formed from hot-dipped galvanized steel; complying with ASTM A1003 and ASTM A653 G40 or equivalent corrosion resistant coating for framing for exterior soffits and where indicated.

F. Steel Studs for Furring Channels: ASTM C 645-08, with flange edges of studs bent back 90 degrees and doubled over to form 3/16-inch- wide minimum lip (return), and complying with the following requirements for minimum thickness of base (uncoated) metal and for depth:

1. Thickness: 0.0179 inch (25 gage) or members that can show certified third party testing in accordance with ICC – ES – AC86 that meets ASTM C645-08 Section 9.2. unless otherwise indicated.

2. Depth: 2-1/2 inches unless otherwise indicated.

3. Protective Coating: c Meeting requirements of ASTM C645-08; C-channel, roll-formed from hot-dipped galvanized steel; complying with ASTM A1003 and ASTM A653 G40 or equivalent corrosion resistant coating.

4. Subject to compliance with requirements, provide Dietrich UltraSTEEL™ (25 gauge equivalent).

A. Steel Rigid Furring Channels: ASTM C 645-08, hat shaped, depth of 7/8 inch and minimum thickness 0.0179 inch or members that can show certified third party testing in accordance with ICC – ES – AC86 that meets ASTM C645-08 Section 9.2. unless otherwise indicated. Protective Coating Meeting requirements of ASTM C645-08; C-channel, roll-formed from hot-dipped galvanized steel; complying with ASTM A1003 and ASTM A653 G40 or equivalent corrosion

resistant coating1. Subject to compliance with requirements, provide Dietrich UltraSTEEL™ **(25 gauge equivalent) (20 gauge equivalent).**

2.4 GYPSUM BOARD PRODUCTS

A. General: Provide gypsum board of types indicated in maximum lengths available that will minimize end-to-end butt joints in each area indicated to receive gypsum board application. Provide gypsum board in widths of 48 inches.
   1. Provide tapered edges, **5/8 inch** thickness, unless otherwise indicated.
   2. At curved surfaces, Installer may provide multiple layers of equivalent thickness.

B. Gypsum Wallboard for Single and multilayer applications: ASTM **WITHDRAWN, REPLACED BY C1396/C1396M** and as follows:
   3. Type: Regular except **Type X or Type C** where fire rated assembly is noted or required.
   4. Type: Sag-resistant type for ceiling surfaces.

C. Abuse-Resistant Type: Manufactured to produce greater resistance to surface indentation, through-penetration (impact resistance), and abrasion than standard, regular-type and Type X gypsum board.
   1. Core Type: Regular except **Type X or Type C** where fire rated assembly is noted or required.
   2. Thickness: **5/8 inch** unless otherwise indicated.

D. Exterior Gypsum Soffit Board: ASTM **WITHDRAWN, REPLACED BY C1396/C1396M**, with manufacturer's standard edges, of type and thickness indicated below:
   1. Type: Water resistant typical
   2. Core Type: Regular except **Type X** where fire rated assembly is noted or required.

E. Water-Resistant (green board) Gypsum Backing Board: ASTM **WITHDRAWN, REPLACED BY C1396/C1396M**. Type, edges and thickness to be the same as gypsum wall board.
   1. Core Type: Regular except **Type X or Type C** where fire rated assembly is noted or required.

2.5 GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. General: Characteristics of selected components are described below for purposes of indicating proprietary gypsum board shaft-wall assemblies that are manufacturer's standard. Provide complete shaft-wall assemblies that comply with requirements indicated in this Article and Part 1 "Assembly Performance Requirements" Article.

B. Cavity Shaft-Wall Assemblies: Provide assemblies constructed of proprietary gypsum liner panels inserted between steel tracks at each end of studs; with specially shaped steel studs engaged in tracks and fitted between gypsum liner panels; and with gypsum board on finished side or sides applied to studs in the number of layers, thicknesses and arrangement indicated.

C. Gypsum Liner Panels: Proprietary liner panels as required for the specific fire-resistant-rated gypsum board shaft-wall assemblies indicated, with moisture-resistant paper facings. Thickness: 1 inch.

D. Stud Shape: As standard with manufacturer for gypsum board shaft-wall assemblies indicated. Provide C-H/CT shape or equivalent. Stud Thickness as required but not les than 20 gage. Stud Depth not less than 2-1/2 inches.

1. Subject to compliance with requirements, provide Dietrich CT studs and J-Tabbed Track.

2.6 CEMENTITIOUS BACKER UNITS

A. Provide cementitious backer units complying with ANSI A118.9, of thickness and width indicated below, and in maximum lengths available to minimize end-to-end butt joints.

1. Thickness: Manufacturer's standard thickness, but not less than 7/16 inch unless otherwise indicated.

2. Width: Manufacturer's standard width, but not less than 32 inches

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

1. The Original Wonderboard; Custom Building Products.
2. Wonderboard Multi+Board; Custom Building Products.
3. DomCrete Cementitious Tile-Backer Board; Domtar Gypsum.
4. Util-A-Crete Concrete Backer Board; FinPan, Inc.
5. DUROCK Cement Board; United States Gypsum Co.

2.7 TRIM ACCESSORIES

A. Accessories for Interior Installation: Cornerbead, edge trim, and control joints complying with ASTM C 1047 and requirements indicated below:

1. Material: Formed metal or plastic, with metal complying with the following requirement:

2. Steel sheet zinc coated by hot-dip process or rolled zinc.

3. Shapes indicated below by reference to Fig. 1 designations in ASTM C 1047.
4. Cornerbead on outside corners, unless otherwise indicated.

5. Subject to compliance with requirements, provide drywall trims and accessories by [Dietrich Metal Framing] or equivalent.

B. Edge bead metal trim (LC-bead or L-bead with face flange formed to receive joint compound.) where edge of gypsum board would otherwise be exposed or semi-exposed; L-type for tight abutment at edges, otherwise LC-type, similar to USG 200A/Dietrich M20A. (U-bead, USG 400 Series trim or similar is not acceptable.)
1. Subject to compliance with requirements, provide Dietrich™ Metal Trims M20A.

C. One-piece control joint formed with V-shaped slot and removable strip covering slot opening.

D. Cornerbead on outside corners, unless otherwise indicated.

E. Edge trim complying with shape LC-bead per Fig. 1, unless otherwise indicated.

F. One-piece control joint formed from rolled zinc with V-shaped slot and removable strip covering slot opening.

G. Aluminum Reglet Trim: Extruded accessories of profiles and dimensions indicated.

1. Z molding Fry Reglet Corp. DRMZ-625-75 or equal. Other trim as required to suit conditions.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Fry Reglet Corp.
   b. Gordon, Inc.
   c. Pittcon Industries.

3. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.

4. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified

2.8 JOINT TREATMENT MATERIALS

A. General: Provide joint treatment materials complying with ASTM C 475 and the recommendations of both the manufacturers of sheet products and of joint treatment materials for each application indicated.

B. Joint Tape for Gypsum Board: Paper reinforcing tape, unless otherwise indicated.

C. Use pressure-sensitive or staple-attached, open-weave, glass-fiber reinforcing tape with compatible joint compound where recommended by manufacturer of gypsum board and joint treatment materials for application indicated.

E. Joint Tape for Cementitious Backer Units: As recommended by cementitious backer unit manufacturer.

F. Sheathing Tape: Tape specifically designed and manufactured to seal joints in gypsum sheathing against water and air infiltration, formulated with an adhesive that permanently bonds to gypsum sheathing substrates. Provide one of the following or other as recommended by sheathing Manufacturer:

G. Linerless, polypropylene sheathing tape, 0.0027 inch (0.07 mm) thick, 2-1/2 inches (63 mm) wide, composed of oriented polypropylene backing coated with permanent acrylic adhesive formulated to adhere to gypsum sheathing surfaces. No. 8086 Contractor Sheathing Tape; 3M Construction Markets.

H. Polyethylene tape, 0.025 inch (0.63 mm) thick, 3 inches (76 mm) wide, composed of polyethylene backing coated with synthetic-rubber-based adhesive. Perma-Tite Tape--PGM 207A; PermaGlass-Mesh, Inc.

I. Drying-Type Joint Compounds for Gypsum Board: Factory-mixed vinyl-based all-purpose compound formulated for both taping and topping compounds.

J. Joint Compound for Cementitious Backer Units: Material recommended by cementitious backer unit manufacturer.

2.9 ACOUSTICAL SEALANT

A. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834 and the following requirements:

B. Product is effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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

D. Acoustical Sealant for Exposed and Concealed Joints:

1. PL Acoustical Sealant; ChemRex, Inc.; Contech Brands.
2. AC-20 FTR Acoustical and Insulation Sealant; Pecora Corp.
3. SHEETROCK Acoustical Sealant; United States Gypsum Co.

2.10 MISCELLANEOUS MATERIALS

A. General: Provide auxiliary materials for gypsum board construction that comply with referenced standards and recommendations of gypsum board manufacturer.

1. Laminating Adhesive: Special adhesive or joint compound recommended for laminating gypsum panels.

2. Spot Grout: ASTM C 475, setting-type joint compound recommended for spot-grouting hollow metal door frames.

3. Steel drill screws complying with ASTM C 1002 for the following applications:
4. Fastening gypsum board to steel members less than 0.033 inch (0.84 mm) thick And fastening gypsum board to gypsum board:

   a. Steel drill screws complying with ASTM C 954 for fastening gypsum board to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.

   b. Steel drill screws of size and type recommended by unit manufacturer for fastening cementitious backer units.

B. Sound-Attenuation Blankets: Unfaced mineral-fiber blanket insulation produced by combining mineral fibers of type described below with thermosetting resins to comply with ASTM C 665 for Type I (blankets without membrane facing).

1. Mineral-Fiber Type: Fibers manufactured from slag wool or rock wool.

2. Polyethylene Vapor Retarder: ASTM D 4397; 6 mils thickness; 0.13 perms maximum permeance rating

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

4. Thickness: 3” unless noted otherwise

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. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Ceiling Anchorages: Coordinate installation of ceiling suspension systems with installation of overhead structural assemblies to ensure that inserts and other provisions for anchorages to building structure have been installed to receive ceiling hangers that will develop their full strength and at spacing required to support ceilings.

3.3 INSTALLING STEEL FRAMING, GENERAL

A. Installation Standards: ASTM C 754, and ASTM C 840 requirements that apply to framing installation.

B. Install supplementary framing, blocking, and bracing at terminations in gypsum board assemblies to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction. Comply with details indicated and with gypsum board manufacturer's written recommendations or, if none available, with United States Gypsum's "Gypsum Construction Handbook."

C. Isolate steel framing from building structure at locations indicated to prevent transfer of loading imposed by structural movement.
   1. Isolate ceiling assemblies where they abut or are penetrated by building structure.
   2. Isolate partition framing and wall furring where it abuts structure, except at floor. Install slip-type joints at head of assemblies that avoid axial loading of assembly and laterally support assembly.

      Use deep-leg deflection track

D. Do not bridge building control and expansion joints with steel framing or furring members. Frame both sides of joints independently.

3.4 INSTALLING STEEL PARTITION AND SOFFIT FRAMING

A. Install tracks (runners) at floors, ceilings, and structural walls and columns where gypsum board assemblies abut other construction.

1. Where studs are installed directly against exterior walls, install **foam-gasket** isolation strip between studs and wall.

B. Installation Tolerance: Install each steel framing and furring member so fastening surfaces vary not more than 1/8 inch from the plane formed by the faces of adjacent framing.

C. Extend partition framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing over frames for doors and openings and frame around ducts penetrating partitions above ceiling to provide support for gypsum board.

1. For fire-resistance-rated partitions that extend to the underside of floor/roof slabs and decks or other continuous solid-structure surfaces to obtain ratings, install framing around structural and other members extending below floor/roof slabs and decks, as needed to support gypsum board closures and to make partitions continuous from floor to underside of solid structure.

D. Install steel studs and furring at the following spacings:

1. Single-Layer Construction: 16 inches o.c., unless otherwise indicated.

E. Install steel studs so flanges point in the same direction and leading edge or end of each panel can be attached to open (unsupported) edges of stud flanges first.

F. Frame door openings to comply with GA-600 and with gypsum board manufacturer's applicable written recommendations, unless otherwise indicated. Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.

1. Install two studs **of not less than 18 gage** at each jamb, unless otherwise indicated.
2. Extend jamb studs through suspended ceilings and attach to underside of floor or roof structure above.
3. **Where control joints are required install cripple studs at head adjacent to each jamb stud to allow for installation on control joint.**

G. 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.

3.5 INSTALLING VAPOR BARRIERS

A. Install polyethylene vapor retarder on interior face of exterior stud wall to comply with the following requirements:

B. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with mechanical fasteners or adhesives. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose mineral-fiber insulation.

C. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end, and bottom edges, at perimeter of wall openings, and at lap joints; seal to substrate with adhesive tape

D. Seal joints in vapor retarders caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor retarder tape.

E. Repair any tears or punctures in vapor retarder immediately before concealing it with the installation of gypsum board or other construction.

3.6 INSTALLATION OF GYPSUM BOARD SHAFT-WALL ASSEMBLIES

A. Integrate stair hanger rods with gypsum board shaft-wall assemblies where indicated (and where possible) by locating cavity of assemblies where required to enclose rods.

B. At penetrations in shaft wall, maintain fire-resistance rating of entire shaft-wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.

C. Seal gypsum board shaft-walls at perimeter of each section that abuts other work and at joints and penetrations within each section. Install acoustical sealant to withstand dislocation by air pressure differential between shaft and external spaces; comply with manufacturer's instructions and ASTM C 919.

D. Caulk perimeter of base layer panels of all shaft wall assemblies.

3.7 APPLYING AND FINISHING PANELS, GENERAL

A. Gypsum Board Application and Finishing Standards: ASTM C 840 and GA-216.

B. Install sound attenuation blankets before installing gypsum panels, unless blankets are readily installed after panels have been installed on one side.

C. Install gypsum panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Attach gypsum panels to steel studs so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

F. Attach gypsum panels to framing provided at openings and cutouts.

G. Form control and expansion joints with space between edges of adjoining gypsum panels.

H. Cover both faces of steel stud partition framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect open structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit structural members; allow 1/4- to 3/8-inch wide joints to install sealant.

I. Isolate perimeter of non-load-bearing gypsum board partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch wide spaces at these locations, and trim edges with LC-bead edge trim where edges of gypsum panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

J. Space fasteners in gypsum panels according to referenced gypsum board application and finishing standard and manufacturer's written recommendations.

1. Space screws a maximum of 12 inches o.c. for vertical applications.

3.8 PANEL APPLICATION METHODS

A. Single-Layer Application:

1. On partitions/walls, apply gypsum panels vertically (parallel to framing), unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
2. Locate edge joints over framing member
3. Stagger abutting end joints not less than one framing member in alternate courses of board.
4. On furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.

B. Single-Layer Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Wall Tile Substrates: For substrates indicated to receive thin-set ceramic tile and similar rigid applied wall finishes, comply with the following:

1. Install cementitious backer units to comply with ANSI A108.11 at locations indicated to receive wall tile.

D. Install water-resistant gypsum backing board panels where indicated and described herein.
1. Toilet Rooms
2. Shower Rooms
3. Drinking Fountains alcoves
4. All partitions to receive Epoxy Paint
5. All partitions to receive ceramic tile or cement backer board.
6. Where indicated.

3.9 INSTALLING TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions. Install cornerbead at external corners.

B. Install edge trim where edge of gypsum panels would otherwise be exposed. Provide edge trim type with face flange formed to receive joint compound, except where other types are indicated.

C. Install LC-bead where gypsum panels are tightly abutted to other construction and back flange can be attached to framing or supporting substrate.

D. Install control joints at required locations, and where indicated. Provide in gypsum board partitions grater than 30 ft in length without change in plan or direction. ASTM C 840, manufacturer's recommendations, and in specific locations approved by Architect for visual effect

E. Install Aluminum Reglet Trim at all location where indicated or where reveals are indicated in gypsum board assemblies.

A. FINISHING GYPSUM BOARD ASSEMBLIES

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints and damaged surface areas.

C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:

1. Level 1: Embed tape at joints **in ceiling plenum areas, fully concealed areas, and where indicated.**

2. Level 4: Typical unless noted otherwise: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at **all panel surfaces that will be exposed to view, unless otherwise indicated**. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration. Use ready-mixed, drying-type, all-purpose or topping compound as applicable to the finish levels specified for the following:
    a. Embedding and First Coat
    b. Fill (Second) Coat
    c. Finish (Third) Coat

3. Level 5: Where Level 5 gypsum board finish is indicated, or listed herein, embed tape in joint compound and apply first, fill (second), and finish (third) coats of joint compound over joints, angles, fastener heads, and accessories; and apply a thin, uniform skim coat of joint compound over entire surface. For skim coat, use joint compound specified for third coat, or a product

specially formulated for this purpose and acceptable to gypsum board manufacturer. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects, tool marks, and ridges and ready for decoration. Proved Level 5 Finish at the following locations:

a. All drywall ceilings and soffits
b. All exposed water resistant gypsum wall board. (greenboard and blueboard) to receive painted finish
c. All exposed abuse resistant gypsum wall board. to receive painted finish
d. All curved or radiuses drywall surfaces
e. Building Lobby, Including Ornamental Stair And Adjacent Spaces Including Corridor 461
f. Skylight Lightwell, Corridors 560 And 270

3.10 FINISHING GYPSUM BOARD ASSEMBLIES

E. 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.

F. Prefill open joints and damaged surface areas.

G. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.

H. Gypsum Board Finish Levels: Finish panels to levels indicated below, according to ASTM C 840, for locations indicated:

1. Level 1: Embed tape at joints in ceiling plenum areas, concealed areas, and where indicated.

2. Level 4: Embed tape and apply separate first, fill, and finish coats of joint compound to tape, fasteners, and trim flanges at all panel surfaces that will be exposed to view, unless otherwise indicated. Touch up and sand between coats and after last coat as needed to produce a surface free of visual defects and ready for decoration. Use ready-mixed, drying-type, all-purpose or topping compound as applicable to the finish levels specified for the following:
    a. Embedding and First Coat
    b. Fill (Second) Coat
    c. Finish (Third) Coat

END OF SECTION 09260

SECTION 093000 - CERAMIC TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Ceramic mosaic tile.
2. Glazed wall tile.
3. Metal edge strips installed as part of tile installations.

B. Related Sections include the following:

1. Division 3 Section "Cast-in-Place Concrete" for monolithic slab finishes specified for tile substrates.
2. Division 7 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

1.3 DEFINITIONS

A. Module Size: Actual tile size (minor facial dimension as measured per ASTM C 499) plus joint width indicated.

B. Facial Dimension: Actual tile size (minor facial dimension as measured per ASTM C 499).

C. Facial Dimension: Nominal tile size as defined in ANSI A137.1.

1.4 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.
2. Step Treads: Minimum 0.6.
3. Ramp Surfaces: Minimum 0.8.

1.5 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

D. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

E. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Assembled samples with grouted joints for each type and composition of tile and for each color and finish required, at least 12 inches (300 mm) square and mounted on rigid panel. Use grout of type and in color or colors approved for completed work.
3. Full-size units of each type of trim and accessory for each color and finish required.
4. Stone thresholds in 6-inch (150-mm) lengths.
5. Metal edge strips in 6-inch (150-mm) lengths.

F. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.

G. Product Certificates: For each type of product, signed by product manufacturer.

H. Qualification Data: For Installer.

I. Material Test Reports: For each tile-setting and -grouting product.

1.6 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.

1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:

1. Stone thresholds.
2. Waterproofing.
3. Joint sealants.
4. Cementitious backer units.
5. Metal edge strips.

D. Mockups: Build mockups to verify selections made under sample Submittals and to demonstrate aesthetic effects.

1. Build mockup of each type of floor tile installation.
2. Build mockup of each type of wall tile installation.
3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquid latexes and emulsion adhesives in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed, for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
2. For facial dimensions of tile, comply with requirements relating to tile sizes specified in Part 1 "Definitions" Article.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI standards referenced in "Setting and Grouting Materials" Article.

C. Colors, Textures, and Patterns: Where manufacturer's standard products are indicated for tile, grout, and other products requiring selection of colors, surface textures, patterns, and other appearance characteristics, provide specific products or materials complying with the following requirements:

a. As indicated by manufacturer's designations.

D. Factory Blending: For tile exhibiting color variations within ranges selected during Sample submittals, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

E. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.

1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

F. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

A. Tile Type: WT-1 – WT-3: Factory mounted glazed porcelain tile.

B. Basis-of-Design Product: The design for each tile type is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified:
1. American Olean; Div. of Dal-Tile International Corp.
2. Crossville Ceramics Company, L.P.
3. Daltile; Div. of Dal-Tile International Inc.
4. GranitiFiandre.
5. Monarch Tile, Inc.
6. Seneca Tiles, Inc.
7. Summitville Tiles, Inc.

C. Glazed Porcelain Wall Tile WT-2: Factory-mounted flat tile as follows:

1. Composition: Porcelain.
2. Surface: Smooth, without abrasive admixture.
3. Module Size: 6” x 6” (14.7 cm x 14.7 cm).
4. Nominal Thickness: 5/16” inch.
5. Face: Plain with cushion edges.
6. Basis-of-Design Product: Daltile, Colour Scheme Color: B911 Luminary Gold or a comparable product of one of the following:

    a. American Olean.
    b. Crossville Ceramics.

D. Glazed Porcelain Wall Tile WT-2: Factory-mounted flat tile as follows:

1. Composition: Porcelain.
2. Surface: Smooth, without abrasive admixture.
3. Module Size: 6” x 6” (14.7 cm x 14.7 cm).
4. Nominal Thickness: 5/16” inch (6.35 mm).
5. Face: Plain with cushion edges.
6. Basis-of-Design Product: Daltile, Colour Scheme; Color: B933 Galaxy Speckle or a comparable product of one of the following:

    a. American Olean.
    b. Crossville Ceramics.

E. Glazed Porcelain Floor Tile WT-1/CT-1: Factory-mounted flat tile as follows:

1. Composition: Porcelain.
2. Surface: Smooth, without abrasive admixture.
3. Module Size: 12” x 12” (3.0 cm x 3.0 cm).
4. Nominal Thickness: 5/16”.
5. Face: Plain with cushion edges.
6. Basis-of-Design Product: Daltile, Colour Scheme Color: B929 Bisquit Speckle or a comparable product of one of the following:

a. American Olean.
b. Crossville Ceramics.

F. Glazed Porcelain Floor Tile CT-2: Factory-mounted flat tile as follows:

1. Composition: Porcelain.
2. Surface: Smooth, without abrasive admixture.
3. Module Size: 12” x 12” (3.0 cm x 3.0 cm).
4. Nominal Thickness: 5/16”.
5. Face: Plain with cushion edges.
6. Basis-of-Design Product: Daltile, Colour Scheme Color: B911 Luminary Gold or a comparable product of one of the following:

   a. American Olean.
   b. Crossville Ceramics.

G. Glazed Porcelain Floor Tile CT-3: Factory-mounted flat tile as follows:

1. Composition: Porcelain.
2. Surface: Smooth, without abrasive admixture.
3. Module Size: 12” x 12” (3.0 cm x 3.0 cm).
4. Nominal Thickness: 5/16”.
5. Face: Plain with cushion edges.
6. Basis-of-Design Product: Daltile, Colour Scheme Color: B933 Galaxy Speckle or a comparable product of one of the following:

   a. American Olean.
   b. Crossville Ceramics.

H. Glazed Wall Tile Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:

1. Base for Thin-Set Mortar Installations: Straight, module size 4-1/4 by 4-1/4 inches (108 by 108 mm).
2. External Corners for Thin-Set Mortar Installations: Surface bullnose.
3. Internal Corners: Field-butted square corners except with coved base and cap angle pieces designed to fit with stretcher shapes.

I. Ceramic Mosaic Trim Units: Matching characteristics of adjoining flat tile and coordinated with sizes and coursing of adjoining flat tile where applicable. Provide shapes as follows, selected from manufacturer's standard shapes:

1. Base Cove: Cove, module size 2 by 1 inch (50.8 by 25.4 mm).
2. Base Cap for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 2 inches (50.8 by 50.8 mm).
3. External Corners for Thin-Set Mortar Installations: Surface bullnose, module size 2 by 2 inches (50.8 by 50.8 mm).
4. Internal Corners: Cove, module size 2 by 1 inch (50.8 by 25.4 mm).

5. Tapered Transition Tile: Shape designed to effect transition between thickness of tile floor and adjoining floor finishes of different thickness, tapered to provide reduction in thickness from 1/2 to 1/4 inch (12.7 to 6.35 mm) across nominal 4-inch (100-mm) dimension.

2.3 THRESHOLDS

A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.

1. Bevel edges at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2 inch (12.7 mm) or less, and finish bevel to match face of threshold.

B. Marble Thresholds: ASTM C 503 with a minimum abrasion resistance of 10 per ASTM C 1353 or ASTM C 241 and with honed finish.

1. Description: Uniform, fine- to medium-grained white stone with gray veining.

2.4 SETTING AND GROUTING MATERIALS

A. Available Manufacturers:

1. Atlas Minerals & Chemicals, Inc.
2. Boiardi Products Corporation.
3. Bonsal, W. R., Company.
4. Bostik.
5. C-Cure.
6. Custom Building Products.
7. DAP, Inc.
8. Jamo Inc.
9. LATICRETE International Inc.
10. MAPEI Corporation.
11. Southern Grouts & Mortars, Inc.
12. Summitville Tiles, Inc.
13. TEC Specialty Products Inc.

B. Dry-Set Portland Cement Mortar (Thin Set): ANSI A118.1.

1. For wall applications, provide nonsagging mortar that complies with Paragraph C-4.6.1 in addition to the other requirements in ANSI A118.1.

C. Latex-Portland Cement Mortar (Thin Set): ANSI A118.4, consisting of the following:

1. Prepackaged dry-mortar mix containing dry, redispersible, ethylene vinyl acetate additive to which only water must be added at Project site.
2. Prepackaged dry-mortar mix combined with acrylic resin liquid-latex additive.

a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.

D. Standard Sanded Cement Grout: ANSI A118.6, color as indicated.

E. Standard Unsanded Cement Grout: ANSI A118.6, color as indicated.

F. Polymer-Modified Tile Grout: ANSI A118.7, color as indicated.

1. Polymer Type: Ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients.
2. Polymer Type: Acrylic resin in liquid-latex form for addition to prepackaged dry-grout mix.
3. Polymer Type: Either ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.

    a. Unsanded grout mixture for joints 1/8 inch (3.2 mm) and narrower.
    b. Sanded grout mixture for joints 1/8 inch (3.2 mm) and wider.

2.5 ELASTOMERIC SEALANTS

A. General: Provide manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated that comply with applicable requirements in Division 7 Section "Joint Sealants."

1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints, unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

1. Available Products:

    a. Dow Corning Corporation; Dow Corning 786.
    b. GE Silicones; Sanitary 1700.
    c. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
    d. Tremco, Inc.; Tremsil 600 White.

D. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.

1. Available Products:

    a. Bostik; Chem-Calk 550.
    b. Mameco International, Inc.; Vulkem 245.
    c. Pecora Corporation; NR-200 Urexpan.
    d. Tremco, Inc.; THC-900.

2.6 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications, stainless steel; ASTM A 666, 300 Series exposed-edge material.

C. Temporary Protective Coating: Product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F (49 to 60 deg C) per ASTM D 87.

2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard product for sealing grout joints that does not change color or appearance of grout.

1. Available Products:

a. Bonsal, W. R., Company; Grout Sealer.
b. Bostik; CeramaSeal Grout Sealer.
c. C-Cure; Penetrating Sealer 978.
d. Custom Building Products; Grout and Tile Sealer.
e. Jamo Inc.; Penetrating Sealer.
f. MAPEI Corporation; KER 004, Keraseal Penetrating Sealer for Unglazed Grout and Tile.
g. Southern Grouts & Mortars, Inc.; Silicone Grout Sealer.
h. Summitville Tiles, Inc.; SL-15, Invisible Seal Penetrating Grout and Tile Sealer.
i. TEC Specialty Products Inc.; TA-256 Penetrating Silicone Grout Sealer.

F. Edge Protection Profile: At exterior corners provide Schluter - Quadec square edge profile, stainless steel 304 (E) or approved equal.

2.7 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm; dry; clean; free of oil, waxy films, and curing compounds; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.

2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove coatings, including curing compounds and other substances that contain soap, wax, oil, or silicone, that are incompatible with tile-setting materials.

B. Provide concrete substrates for tile floors installed with thin-set mortar that comply with flatness tolerances specified in referenced ANSI A108 Series of tile installation standards.

1. Fill cracks, holes, and depressions with trowelable leveling and patching compound according to tile-setting material manufacturer's written instructions. Use product specifically recommended by tile-setting material manufacturer.

2. Remove protrusions, bumps, and ridges by sanding or grinding.

C. Blending: For tile exhibiting color variations within ranges selected during Sample submittals, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

D. Field-Applied Temporary Protective Coating: Where indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 INSTALLATION, GENERAL

A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.

C. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

D. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

E. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.

F. Lay out tile wainscots to next full tile beyond dimensions indicated.

G. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Locate joints in tile surfaces directly above joints in concrete substrates.

2. Prepare joints and apply sealants to comply with requirements in Division 7 Section "Joint Sealants."

H. Grout tile to comply with requirements of the following tile installation standards:

1. For ceramic tile grouts (sand-portland cement; dry-set, commercial portland cement; and latex-portland cement grouts), comply with ANSI A108.10.
2. For chemical-resistant epoxy grouts, comply with ANSI A108.6.
3. For chemical-resistant furan grouts, comply with ANSI A108.8.

I. At showers, tubs, and where indicated, install cementitious backer units and treat joints to comply with ANSI A108.11 and manufacturer's written instructions for type of application indicated.

3.4 FLOOR TILE INSTALLATION

A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.

1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.

a. Tile floors in wet areas.
b. Tile floors in laundries.
c. Tile floors composed of rib-backed tiles.

B. Joint Widths: Install tile on floors with the following joint widths:

1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).

C. Stone Thresholds: Install stone thresholds at locations indicated; set in same type of setting bed as abutting field tile, unless otherwise indicated.

1. Set thresholds in latex-portland cement mortar for locations where mortar bed would otherwise be exposed above adjacent nontile floor finish.

D. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with top of tile.

E. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.5 WALL TILE INSTALLATION

A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.

B. Install metal lath and scratch coat for walls to comply with ANSI A108.1A, Section 4.1.

C. Joint Widths: Install tile on walls with the following joint widths:

1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).
2. Glazed Wall Tile: 1/16 inch (1.6 mm).

3.6 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove latex-portland cement grout residue from tile as soon as possible.

2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

3. Remove temporary protective coating by method recommended by coating manufacturer that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

B. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.

D. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.7 FLOOR TILE INSTALLATION SCHEDULE

A. Tile Installation CT-1, CT-3: Interior floor installation on concrete; thin-set mortar; TCA F113 and ANSI A108.5.

1. Tile Type: Unglazed ceramic mosaic tile.
2. Thin-Set Mortar: Latex-portland cement mortar.
3. Grout: Polymer-modified unsanded grout.

3.8 WALL TILE INSTALLATION SCHEDULE

A. Tile Installation WT-1, WT-2, WT-3: Interior wall installation over gypsum board; thin-set mortar; TCA W243 and ANSI A108.5.

1. Tile Type: Glazed wall tile.
2. Thin-Set Mortar: Latex-portland cement mortar.
3. Grout: Polymer-modified sanded grout.

END OF SECTION 093000

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes acoustical panels and exposed suspension systems for ceilings.

B. Related Sections include the following:

1. Division 09 Section "Acoustical Tile Ceilings" for ceilings consisting of mineral-base acoustical tiles used with concealed suspension systems, stapling, or adhesive bonding.

C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete at ceilings.

1.3 DEFINITIONS

A. AC: Articulation Class.

B. CAC: Ceiling Attenuation Class.

C. LR: Light Reflectance coefficient.

D. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members.
2. 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.

3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
4. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

D. Samples for Initial Selection: For components with factory-applied color finishes.

E. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Acoustical Panel: Set of 6-inch- (150-mm-) square Samples of each type, color, pattern, and texture.
2. Exposed Suspension System Members, Moldings, and Trim: Set of 12-inch- (300-mm-) long Samples of each type, finish, and color.

F. LEED Submittals:

1. Product Data for Credit MR 4.1: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content.

    a. Include statement indicating costs for each product having recycled content.

2. Product Data for Credit EQ 4.1: For sealants, including printed statement of VOC content.

G. Qualification Data: For testing agency.

H. Field quality-control test reports.

I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.

J. Research/Evaluation Reports: For each acoustical panel ceiling and components and anchor and fastener type.

K. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory, or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

B. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
2. Suspension System: Obtain each type through one source from a single manufacturer.

C. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system through one source from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

a. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
b. Identify materials with appropriate markings of applicable testing and inspecting agency.

2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:

a. Smoke-Developed Index: 450 or less.

E. Seismic Standard: Provide acoustical panel ceilings designed and installed to withstand the effects of earthquake motions according to the following:

1. Standard for Ceiling Suspension Systems Requiring Seismic Restraint: Comply with ASTM E 580.
2. UBC Standard 25-2, "Metal Suspension Systems for Acoustical Tile and for Lay-in Panel Ceilings."

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

G. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

1.8 COORDINATION

A. Coordinate layout and installation of acoustical panels and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed.
2. Suspension System Components: Quantity of each exposed component equal to 1.0 percent of quantity installed.
3. Hold-Down Clips: Equal to 2.0 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ACOUSTICAL PANELS, GENERAL

A. Recycled Content: Provide acoustical panels with recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content constitutes a minimum of 1.0% by weight.

B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface per ASTM E 795.

C. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

D. Broad Spectrum Antimicrobial Fungicide and Bactericide Treatment: Provide acoustical panels treated with manufacturer's standard antimicrobial formulation that inhibits fungus, mold, mildew, and gram-positive and gram-negative bacteria and showing no mold, mildew, or bacterial growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

E. Antimicrobial Fungicide Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273 and evaluated according to ASTM D 3274 or ASTM G 21.

2.2 ACOUSTICAL PANELS FOR ACOUSTICAL PANEL CEILING – ACP. 1

A. Basis-of-Design Product: Subject to compliance with requirements, provide USG Interiors Inc., Radar Climaplus, High CAC, High NRC #22121 or a comparable product by one of the following:
1. BPB USA.
2. Chicago Metallic Corporation.
3. Ecophon CertainTeed, Inc.
4. Tectum Inc.
5. Armstrong World Industries

B. Classification: Provide fire-resistance-rated panels complying with ASTM E 1264 for type, form, and pattern as follows:
1. Type and Form: Type III, mineral base with membrane-faced overlay; Form 2, water felted; with factory applied acrylic latex paint.
2. Pattern: CDE (perforated, small holes & lightly textured).

C. Color: White.

D. LR: Not less than 0.84.

E. NRC: Not less than 0.70.

F. CAC: Not less than 35.

G. Edge/Joint Detail: Beveled Tegular.

H. Thickness: 3/4 inch (19 mm).

I. Modular Size: 24 by 24 inches (610 by 610 mm).

J. Antimicrobial Treatment: Broad spectrum fungicide and bactericide based.

METAL SUSPENSION SYSTEMS, GENERAL

K. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

L. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.

M. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.

1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

N. Attachment Devices: Size for five times the design load indicated in ASTM C 635, 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 per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

a. Type: Postinstalled expansion anchors.
b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
c. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.
d. Corrosion Protection: Components fabricated from nickel-copper-alloy rods complying with ASTM B 164 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 10 times that imposed by ceiling construction, as determined by testing per ASTM E 1190, conducted by a qualified testing and inspecting agency.

O. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
3. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
4. Size: Select wire diameter so its stress at 3 times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.135-inch- (3.5-mm-) diameter wire.

P. Hanger Rods: steel, zinc coated or protected with rust-inhibitive paint.

Q. 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 A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 5/16-inch- (8-mm-) diameter bolts.

R. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.

S. Impact Clips: Where indicated, provide manufacturer's standard impact-clip system designed to absorb impact forces against acoustical panels.

2.3 METAL SUSPENSION SYSTEM FOR ACOUSTICAL PANEL CEILING

A. Basis-of-Design Product: Subject to compliance with requirements, provide USG Interiors – Donn DX 15/16 “Exposed” Tee System or a comparable product by one of the following:

1. BPB USA.
2. Chicago Metallic Corporation.
3. Ecophon CertainTeed, Inc.
4. Armstrong World Industries.

B. Wide-Face, Capped, Double-Web, Fire-Rated Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 (Z90) coating designation, with prefinished 15/16-inch- (24-mm-) wide metal caps on flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) or Butt-edge type.
3. Face Design: Flat, flush.
4. Cap Material: Steel cold-rolled sheet.
5. Cap Finish: Painted white.

2.4 METAL EDGE MOLDINGS AND TRIM

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

1. Armstrong World Industries, Inc.;
2. BPB USA; <
3. Chicago Metallic Corporation;
4. Fry Reglet Corporation;
5. USG Interiors, Inc.;

B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension system runners.

1. Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension systems indicated and that match width and configuration of exposed runners, unless otherwise indicated.
2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

C. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:

1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 (ASTM B 221M) for Alloy and Temper 6063-T5.
2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
3. Conversion-Coated Finish: AA-M12C42 (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating).
4. Conversion-Coated and Factory-Primed Finish: AA-M12C42R1x (Chemical Finish: cleaned with inhibited chemicals; acid-chromate-fluoride-phosphate conversion coating; organic coating as follows):

    a. Manufacturer's standard, factory-applied prime-coat finish ready for field painting.

5. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
6. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.

a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils (0.02 to 0.03 mm).

2.5 ACOUSTICAL SEALANT

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

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

1. Acoustical Sealant for Exposed and Concealed Joints:

a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
b. USG Corporation; SHEETROCK Acoustical Sealant.
c. Approved equal.

C. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex sealant[**,** with a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24), complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

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.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic design requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. 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.
4. 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.
5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
6. 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 structure to which hangers are attached and 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.
7. 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.
8. 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.
9. Do not attach hangers to steel deck tabs.
10. Do not attach hangers to steel roof deck. Attach hangers to structural members.
11. 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.
12. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

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, leveling with ceiling suspension system

to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). 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 a neat, precise fit.

1. Arrange directionally patterned acoustical panels as follows:

   a. As indicated on reflected ceiling plans.

2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. 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 clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.
7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer's written instructions.
8. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections and prepare reports:

1. Suspended ceiling system.
2. Hangers, anchors and fasteners.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

C. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. 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. Extent of Each Test Area: When installation of ceiling suspension systems on each floor has reached 20 percent completion but no panels have been installed.

    a. Within each test area, testing agency will select 1 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 2 postinstalled anchors used to attach bracing wires to concrete and will test them for 440 lbf (1957 N) of tension.
    b. 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. Remove and replace acoustical panel ceiling hangers and anchors and fasteners that do not pass tests and inspections and retest as specified above.

3.5 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113

SECTION 096513 - RESILIENT WALL BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Wall base.
2. Molding accessories.

B. Related Sections include the following:

1. Division 9 Section 096519 – “Resilient Floor Tile "

1.3 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Samples for Initial Selection: For each type of product indicated.

D. Samples for Verification: For each type of product indicated, in manufacturer's standard-size Samples but not less than 12 inches (300 mm) long, of each resilient product color, texture, and pattern required.

1.4 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: Provide resilient stair accessories with a critical radiant flux classification of Class I, not less than 0.45 W/sq. cm, as determined by testing identical products per ASTM E 648 by a testing and inspecting agency acceptable to authorities having jurisdiction.

1.5 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).

1.6 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile 48 hours, before, during and after installation.

B. 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.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

PART 2 - PRODUCTS

2.1 RESILIENT WALL BASE - PROFILED (RB-1)

A. Resilient Base: Basis-of-Design: Products: Subject to compliance with requirements, provide Johnsonite; Millwork or a comparable product by one of the following: Roppe.

a. Johnsonite.
b. Approved equal.

1. Wall Base: ASTM F 1861.
2. Type (Material Requirement): TP (Rubber, Thermoplastic)..
3. Group (Manufacturing Method): I (solid, homogeneous).
4. Style: Profiled – Reveal MW-80-F6.

5. Minimum thickness: 1/4 inch.
6. Height: 6 inches unless noted otherwise.
7. Coordinate height selected above with length selected below; some manufacturers do not offer coils for every height.
8. Lengths: Coils in manufacturer's standard length.
9. Outside Corners: Job formed.
10. Inside Corners: Job formed.
11. Surface: Smooth.
12. Color: #80 Fawn.

2.2 RESILIENT WALL BASE - COVE 4" (RB-2)

A. Resilient Base: Basis-of-Design: Products: Subject to compliance with requirements, provide Johnsonite; Pinnacle or a comparable product by one of the following:

a. Roppe.
b. Approved equal.

1. Wall Base: ASTM F 1861.
2. Type (Material Requirement): TP (Rubber, Thermoplastic)
3. Group (Manufacturing Method): I (solid, homogeneous).
4. Style: Cove
5. Minimum thickness: 1/4 inch
6. Height: 4 inches unless noted otherwise.
7. Lengths: Coils in manufacturer's standard length
8. Outside Corners: Job formed
9. Inside Corners: Job formed
10. Surface: Smooth.
11. Color: #80 Fawn B-2.

2.3 RESILIENT MOLDING ACCESSORY

A. Resilient Molding Accessory:

1. Manufacturer: Basis-of-Design Product: Subject to compliance with requirements, provide Johnsonite or a comparable product.

B. Description: Transition and joiner strips as described herein and as indicated on drawings, including but not limited to:

1. Reducer strip for resilient floor covering.
2. Transition strips.

C. Material: Rubber.

D. Profile and Dimensions: As required. Verify width to suit conditions.

E. Colors: #80 Fawn

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 manufacturers for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a. Cove Base Adhesives: 50 g/L.
b. Rubber Floor Adhesives: 60 g/L.

C. Metal Edge Strips: Extruded aluminum with mill finish of width show, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.

D. Floor Movement Joint: Schluter Model DILEX-KS, low profile stainless steel, Model EKSB. Size for depth of flooring material, Locate and as indicated and where resilient flooring is installed across floor construction joints subject to movement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

B. Concrete Substrates for Products: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
3. Moisture Testing: Perform tests recommended by manufacturer and as follows: Proceed with installation only after substrates pass testing.

a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level measurement.

C. 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.

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

E. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

1. Do not install resilient products until they are the same temperature as the space where they are to be installed.

F. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 RESILIENT WALL BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply wall 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 wall base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere wall base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch wall base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of wall base with manufacturer's recommended adhesive filler material.

G. Preform Corners: Install preform corners before installing straight pieces.

H. Job-Formed Corners:

1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends. Shave back of base at points where bends occur and remove strips perpendicular to length of base that are only deep enough to produce a snug fit without removing more than half the wall base thickness.

2. Inside Corners: Use straight pieces of maximum lengths possible. Form by cutting an inverted V-shaped notch in toe of wall base at the point where corner is formed. Shave back of base where necessary to produce a snug fit to substrate.

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 coverings that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

    a. Do not wash surfaces until after time period recommended by manufacturer.

B. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer.

1. Apply protective floor polish to surfaces that are free from soil, visible adhesive and surface blemishes as recommended in writing by manufacturer.

    a. Coordinate selection of floor polish with Owner's maintenance service.
    b. Apply a minimum of three coats.

2. Cover products with un-dyed, untreated building paper until Substantial Completion.
3. Do not move heavy and sharp objects directly over surfaces. Place plywood or hardboard panels over surfaces and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 096513

SECTION 096519 - RESILIENT TILE FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Rubber Floor.

B. Related Sections include the following:

1. Division 9 Section 096513 - "Resilient Wall Base and Accessories" for resilient wall base, reducer strips, and other accessories installed with resilient floor tile.

1.3 SUBMITTALS

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

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Samples for Verification: Full-size units of each color and pattern of resilient floor tile required.

D. Layout Drawings: Submit dimensioned layout plan for all locations with flooring pattern, Indicate the following:
1. Type of installation.
2. Indicate starting point(s).
3. Confirm location of columns, doorways, stairs, enclosing walls and/or partitions, built-in cabinets, and other elements which could affect pattern layout; pattern of installation, including field verified dimensions.

4. Type, color, and location of insets and borders, edges, transitions to other flooring materials, divider strips and other accessories.
5. Transition details.

E. Maintenance Data: For each type of floor due to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1. Engage an installer who employs workers for this Project who are trained or certified by manufacturer for installation techniques required.

B. Fire-Test-Response Characteristics: Provide products identical to those tested for fire-exposure behavior per test method indicated by a testing and inspecting agency acceptable to authorities having jurisdiction.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups for floor tile including resilient base and accessories.

a. Size: Minimum 100 sq. ft. (9.3 sq. m) for each type, color, and pattern in locations directed by Architect.

1.5 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). Store tiles on flat surfaces.

1.6 PROJECT CONDITIONS

A. Maintain temperatures within range recommended by manufacturer, but not less than 60 deg F or more than 85 deg F, in spaces to receive floor tile 48 hours before, during and after installation.

B. 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 covering installation.

D. Close spaces to traffic for 48 hours after floor covering installation.

E. Install resilient products after other finishing operations, including painting, have been completed.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Floor Tile: Furnish 1 box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

PART 2 - PRODUCTS

2.1 RESILIENT TILE (RT-1)

A. Products: Basis-of-Design Product: Subject to compliance, provide Nora Systems, Inc., Noraplan Environcare 2942 or a comparable product by one of the following:

1. Roppe
2. Johnsonite
3. Estrie
4. Mannington
5. Endura

B. Hardness: ASTM D2240, Shore type A

C. Static Load: Per ASTM F970 Standard Test method for static load limit, residual compression when tested with 800 lbs +/- 0.005".

D. Quality of cut: ASTM F511 +/- 0. 005".

E. Squareness: ASTM F2055 +/- 0.010".

F. Flammability ASTME 648; NFPA 253: NBSIR 75 950, +/- 0.45 watts per square centimeter, class 1.

G. Smoke Density: ASTM E662, NFPA 258, NBS smoke density +450.

H. Class: I, Homogeneous Vinyl Tile

I. Type: A, Smooth Surface

J. Thickness: 0.080 inch (2.0 mm)

K. Size: 24 by 24 inches.

L. Colors: RT-1: 2942 Evening Bloom

2.2 INSTALLATION MATERIALS

A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic cement based formulation provided or approved by resilient product manufacturer for applications indicated.

B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.

1. Use adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

a. Tile Adhesives: Not more than 50 g/L.
b. Rubber Floor Adhesives: Not more than 60 g/L.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for installation tolerances, moisture content, and other conditions affecting performance.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written recommendations to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
2. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.
3. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing

a. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
b. Perform relative humidity test using in situ probes, ASTM F 2170. Proceed with installation only after substrates have a maximum 75% relative humidity level measurement.

C. 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.

D. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.

E. Fill cracks, holes and depressions in substrates with trowelable leveling and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

F. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

1. Do not install resilient products until they are same temperature as space where they are to be installed.

G. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, and dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 TILE INSTALLATION

A. Lay out tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.

1. Lay tiles square with room axis and in pattern indicated.

B. Match tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.

1. Lay tiles with grain running in one direction.

C. Scribe, cut, and fit tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, edgings, door frames, thresholds, and nosings.

1. Install tiles prior to installation of modular base cabinets and similar built in items and extend complete beneath units.

D. Extend tiles into toe spaces, door reveals, closets, and similar openings.

E. 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, nonstaining marking device.

F. Install tiles on covers for telephone and electrical ducts and similar items in finished floor areas. Maintain overall continuity of color and pattern with pieces of tile installed on covers. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.

G. Adhere tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.

3.4 CLEANING AND PROTECTION

A. Comply with manufacturer’s written instructions for cleaning and protection of floor tile.

B. Perform the following operations immediately after completing resilient product installation:

1. Remove adhesive and other blemishes from exposed surfaces.
2. Sweep and vacuum surfaces thoroughly.
3. Damp-mop surfaces to remove marks and soil.

    a. Do not wash surfaces until after time period recommended by manufacturer.

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. Use protection methods recommended in writing by manufacturer.

D. Apply protective floor polish to horizontal surfaces that are free from soil, visible adhesive and surface blemishes if recommended in writing by manufacturer.

    a. Use commercially available product acceptable to manufacturer.
    b. Coordinate selection of floor polish with Owner's maintenance service.
    c. Apply a minimum of three coats.

E. Cover products installed on horizontal surfaces with undyed, untreated building paper until Substantial Completion.

F. Do not move heavy and sharp objects directly over surfaces. Place hardboard or plywood panels over flooring and under objects while they are being moved. Slide or roll objects over panels without moving panels.

END OF SECTION 096519

SECTION 096813 - CARPET TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes modular, tufted carpet tile.

B. Related Sections include the following:

1. Division 9 Section "Resilient Tile Flooring, Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show the following:

1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
2. Existing flooring materials to be removed.
3. Existing flooring materials to remain.

4. Carpet tile type, color, and dye lot.
5. Type of subfloor.
6. Type of installation.
7. Pattern of installation.
8. Pattern type, location, and direction.
9. Pile direction.
10. Type, color, and location of insets and borders.
11. Type, color, and location of edge, transition, and other accessory strips.
12. Transition details to other flooring materials.

D. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.

1. Carpet Tile: Full-size Sample.
2. Exposed Edge, Transition, and other Accessory Stripping: 12-inch- (300-mm-) long Samples.

E. LEED Submittal:

1. Product Data for Credit EQ 4.3:

a. For carpet tile, documentation indicating compliance with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.
b. For installation adhesive, including printed statement of VOC content.

F. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

G. Qualification Data: For Installer.

H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency.

I. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:

1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

J. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.

B. Fire-Test-Response Characteristics: Provide products with the critical radiant flux classification indicated in Part 2, as determined by testing identical products per ASTM E 648 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

C. Mockups: Before installing carpet tile, build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undamaged at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

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

1.6 PROJECT CONDITIONS

A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."

B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.

D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

1.7 WARRANTY

A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.

1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
2. Failures include, but are not limited to, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, excess static discharge, and delamination.
3. Warranty Period: 10 years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

PART 2 - PRODUCTS

2.1 CARPET TILE – CP-1

A. Manufacturers: Basis-of-Design Product: Subject to compliance with requirements, provide C&A, A Tandus Company; Aura # 02619 or a comparable product by one of the following:

1. Mannington Commercial
2. Interface
3. Bentley
4. Lees Commercial
5. Atlas
6. Shaw

B. Color: # 19508 Vaporize.

C. Pattern: Aura # 02619

D. Fiber Content: 100 percent nylon 6, 6.

E. Fiber Type: Dynex Nylon.

F. Pile Characteristic: Level-loop pile.

G. Density: 65 lbs./cu. Ft.

H. Pile Thickness: 0.187 inches (mm) for finished carpet tile per ASTM D 6859.

I. Stitches: 13.4 stitches per inch (mm).

J. Gage: 5/64 ends per inch (mm).

K. Face Weight: 26 oz./sq. yd. (g/sq. m).
Total Weight: 138.5 oz./sq.yd. (g/sq.m) for finished carpet tile.

L. Primary Backing/Backcoating: Non-Woven Synthetic Fiber.

M. Secondary Backing: 100% recycled content with Tru Bloc (Barrier System).
Intermediate Layer: Fiberglass reinforced sealant.

N. Backing System: ER3 Tile.

O. Size: 24 by 24 inches (60.9 by 60.9 cm).

P. Applied Soil-Resistance Treatment: Ensure.

Q. Antimicrobial Treatment: Manufacturer's standard material.

R. Performance Characteristics: As follows:

1. Critical Radiant Flux Classification: Not less than 0.45 W/sq. cm.
2. Dry Breaking Strength: Not less than 100 lbf (445 N) per ASTM D 2646.
3. Tuft Bind: Not less than 3 lbf (13 N) per ASTM D 1335.
4. Delamination: Not less than 3.5 lbf/in. (15 N/mm) per ASTM D 3936.
5. Dimensional Tolerance: Within 1/32 inch (0.8 mm) of specified size dimensions, as determined by physical measurement.
6. Dimensional Stability: 0.2 percent or less per ISO 2551 (Aachen Test).
7. Resistance to Insects: Comply with AATCC 24.
8. Colorfastness to Crocking: Not less than 4, wet and dry, per AATCC 165.
9. Colorfastness to Light: Not less than 4 after 40 AFU (AATCC fading units) per AATCC 16, Option E.
10. 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; no fungal growth; per AATCC 174.
11. Electrostatic Propensity: Less than 3.5 kV per AATCC 134.
12. Environmental Requirements: Provide carpet tile that complies with testing and product requirements of Carpet and Rug Institute's "Green Label Plus" program.

S. CRI Green Label Plus Certification: GLP1366

T. Total Product Recycled Content: 49.4% (39.4% pre-consumer / 10% post-consuer.

2.2 CARPET Matt – CP-2

A. Manufacturers: Basis-of-Design Product: Subject to compliance with requirements, provide Matts, Inc. – Tough Rib high performance walk-off matt or a comparable product by one of the following:

1. Mannington Commercial
2. Lees Commercial
3. Bentley
4. Atlas
5. Shaw
6. The Anderson Company

B. Color: Charcoal.

C. Pattern: Tough Rib.

D. Fiber Content: 100% UV solution dyed Polypropylene fibers (extra course 800 denier fiber).

E. Pile Characteristic: (Needlepunched).

F. Total Height: 3/8".

G. Surface Pile Weight: 24 oz./sq. yd. (g/sq. m).

H. Primary Backing/Backcoating: Non-staining vinyl.

I. Secondary Backing: Manufacturer's standard material.

J. Pill test (surface flammability): Doc – FF-1-70.

K. LEED – NC Version 3, MP Credit 5.

L. Size: 4'0" x 6'0"".

2.3 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

1. VOC Limits: Provide adhesives with VOC content not more than 50 g/L when calculated according to 40 CFR 59, Subpart D (EPA method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.

2. Subfloor finishes comply with requirements specified in Division 3 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

C. For wood subfloors, verify the following:

1. Underlayment over subfloor complies with requirements specified in Division 6 Section "Rough Carpentry."
2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

D. For metal subfloors, verify the following:

1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

E. For painted subfloors, verify the following:

1. Perform bond test recommended in writing by adhesive manufacturer.

F. For raised access flooring systems, verify the following:

1. Access floor complies with requirements specified in Division 10 Section "Access Flooring."
2. Access floor substrate is compatible with carpet tile and adhesive if any.
3. Underlayment surface is flat, smooth, evenly planed, tightly jointed, and free of irregularities, gaps greater than 1/8 inch (3 mm), protrusions more than 1/32 inch (0.8 mm), and substances that may interfere with adhesive bond or show through surface.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.

B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

H. Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove excess adhesive, seam sealer, and other surface blemishes using cleaner recommended by carpet tile manufacturer.
2. Remove yarns that protrude from carpet tile surface.
3. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protection of Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813

SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Vinyl wall covering.

B. Owner-Furnished Materials: Type II vinyl wall covering.

C. Related Sections:

1. Division 09 Section "Interior Painting”.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.

B. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, seams and termination points.

D. Samples for Initial Selection: For each type of wall covering indicated.

E. Samples for Verification: Full width by 59" wide x 60" long section of wall covering.

1. Sample from same print run or dye lot to be used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of wall cover.

F. Qualification Data: For qualified testing agency.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for wall covering.

H. Maintenance Data: For wall coverings to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Forest Certification: Fabricate products with wood veneer produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."

B. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: As follows, per ASTM E 84:

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 45 or less.

2. Fire-Growth Contribution: Textile wall coverings complying with acceptance criteria of UBC Standard 8-2.
3. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 286 corner burn test and complying with test protocol and criteria in the 2003 IBC.

C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.

1. Build mockups for each type of wall covering on each substrate required. Comply with requirements in ASTM F 1141.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions are maintained at the levels indicated in referenced standard and manufacturers written instructions.

1.6 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Wall-Covering Materials: For each type, full-size units equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 WALL COVERINGS

A. General: Provide rolls of each type of wall covering from same print run or dye lot.

2.2 VINYL WALL COVERING - VWC-1

A. Vinyl Wall-Covering Standards: Provide vinyl wall covering products complying with the following:

1. FS CCC-W-408D.

B. Basis of Design Product: Wolf Gordon – Digital printing substrate with ECO G7603437 Canvas finish, # CDP 303. 5 color custom graphic artwork factory applied. For design intent refer to 1/A-411 and 3/A-411 Interior Elevation. Comparable product of one of the following:

1. Ekyon
2. Koroseal
3. MDC
4. Versa
5. Lanark
6. Bolta

C. Total Weight Excluding Coatings: 300 g/m2

D. Width: wide format 59”.

E. Base Cloth: 100% polyester.

F. Thickness: 0.28 mm

G. Repeat: Random.

H. Colors, Textures, and Patterns: custom 5 color graphics to match Architect’s samples.

2.3 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer and with a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.

C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended by wall-covering manufacturer.

D. Seam Tape: As recommended in writing by wall-covering manufacturer.

E. Metal Primer: Interior ferrous metal primer complying with Division 09 Section "Interior Painting."

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.

1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
2. Plaster: Allow new plaster to cure. Neutralize areas of high alkalinity. Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
3. Metals: If not factory primed, clean and apply metal as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.
4. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

5. Painted Surfaces: Treat areas susceptible to pigment bleeding.

D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

G. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.3 INSTALLATION

A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.

B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.

E. Match pattern 72 inches (1830 mm) above the finish floor.

F. Install seams vertical and plumb at least 6 inches (150 mm) from outside corners and 3 inches (75 mm) from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.

G. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

H. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

3.4 CLEANING

A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200

SECTION 097723 - FABRIC-WRAPPED PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section includes shop-fabricated, fabric-wrapped wall panels.

B. Related Sections:

1. Section 097200 "Wall Coverings" for adhesively applied textile wall coverings and for coordinating requirements for fabric.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of fabric facing, panel edge, core material, and mounting indicated.

A. LEED Submittals:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

B. Shop Drawings: For fabric-wrapped wall panels. Include mounting devices and details; details at panel head, base, joints, and corners; and details at ceiling, floor base, and wall intersections. Indicate panel edge and core materials.

1. Include elevations showing panel sizes and direction of fabric weave and pattern matching.

C. Samples for Verification: For the following products, prepared on Samples of size indicated below:

1. Fabric: Full-width by approximately 36-inch- (900-mm-) long Sample, but not smaller than required to show complete pattern repeat, from dye lot to be used for the Work, and with specified treatments applied. Mark top and face of fabric.
2. Panel Edge: 12-inch- (300-mm-) long Sample(s) showing each edge profile, corner, and finish.
3. Core Material: 12-inch- (300-mm-) square Sample at corner.
4. Mounting Devices: Full-size Samples.
5. Assembled Panels: Approximately 36 by 36 inches (900 by 900 mm), including joints and mounting methods.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Elevations 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. Electrical outlets, switches, and thermostats.
2. Items penetrating or covered by fabric-wrapped wall panels including the following:

    a. Lighting fixtures.
    b. Air outlets and inlets.
    c. Speakers.
    d. Alarms.
    e. Sprinklers.
    f. Access panels.

3. Show operation of hinged and sliding components covered by or adjacent to fabric-wrapped wall panels.

B. Product Certificates: For each type of fabric-wrapped wall panel, from manufacturer.

C. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fabric-wrapped wall panels to include in maintenance manuals. Include fabric manufacturers' written cleaning and stain-removal recommendations.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials from same production run that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fabric: For each fabric, color, and pattern installed, provide length equal to 10 percent of amount installed, but no fewer than 10 yards (9 m).
2. Mounting Devices: Full-size units equal to **5** percent of amount installed, but no fewer than five devices, including unopened adhesives.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain fabric-wrapped wall panels from single source from single manufacturer.

B. Fire-Test-Response Characteristics: Provide fabric-wrapped wall panels meeting the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265.

C. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials, fabrication, and installation.

1. Build mockup of typical wall area as directed by Architect, include intersection of wall and ceiling, corners, and perimeters.
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.

D. Preinstallation Conference: Conduct conference at Project site.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Comply with fabric and fabric-wrapped, wall panel manufacturers' written instructions for minimum and maximum temperature and humidity requirements for shipment, storage, and handling.

B. Deliver materials and panels in unopened bundles and store in a temperature-controlled dry place with adequate air circulation.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install fabric-wrapped wall panels until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work at and above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Lighting: Do not install fabric-wrapped wall panels until a permanent level of lighting is provided on surfaces to receive fabric-wrapped wall panels.

C. Air-Quality Limitations: Protect fabric-wrapped wall panels from exposure to airborne odors such as tobacco smoke, and install panels under conditions free from odor contamination of ambient air.

D. Field Measurements: Verify locations of fabric-wrapped wall panels and actual dimensions of openings and penetrations by field measurements before fabrication.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fabric-wrapped wall panels that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Fabric sagging, distorting, or releasing from panel edge.
b. Warping of core.

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

PART 2 - PRODUCTS

2.1 FABRIC-WRAPPED WALL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated or comparable product by one of the following:

1. Wall Technology, Inc.; an Owens Corning company.
2. Guilford of Maine.
3. Approver equal

B. General Requirements for Fabric-Wrapped Wall Panels: Panels shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

C. Fabric-Wrapped Wall Panel: Manufacturer's standard panel construction consisting of facing material laminated to front face, edges, and back edge border of core.

1. Basis-of-Design Product: Indicated on Drawings.
2. Mounting: Edge mounted with splines secured to substrate.

a. Finish Color at Exposed Edges: Match color of facing material.

3. Mounting: Back mounted with manufacturer's standard metal clips or bar hangers, secured to substrate.
4. Core: Manufacturer's standard.
5. Edge Construction: Manufacturer's standard chemically hardened core with no frame.

6. Edge Profile: Square.
7. Corner Detail in Elevation: Square with continuous edge profile indicated.
8. Reveals between Panels: Flush reveals as selected by Architect from manufacturer's full range or as indicated on Drawings.
9. Facing Material: As indicated on Drawings.
10. Nominal Core Thickness: 1 inch (25 mm).
11. Panel Width: As indicated on Drawings.
12. Panel Height: As indicated on Drawings.

2.2 MATERIALS

A. General:

1. Minimum Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.
2. Regional Materials: Fabric-wrapped wall panels shall be manufactured within 500 miles (800 km) of Project site.
3. Certified Wood: Fabricate products with wood-based components produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship."
4. Acoustical Performance: Sound absorption NRC of not more than 0.35 according to ASTM C 423 for Type A mounting according to ASTM E 795

B. Core Materials:

1. Glass-Fiber Board: ASTM C 612; Type standard with manufacturer; nominal density of 6 to 7 lb/cu. ft. **(96 to 112 kg/cu. m)**, unfaced, and dimensionally stable, molded rigid board; and with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

C. Facing Material (F-1): Fabric from same dye lot; color and pattern as indicated on Drawings.

1. Manufacturer: Guildford of Maine.
2. Product Line/Pattern: as indicated on drawings.
3. Pattern Repeat: as indicated on drawings.
4. Style Number: as indicated on drawings.
5. Color:as indicated on drawings.
6. Fiber Content: 100 percent woven or nonwoven polyester.
7. Width: as indicated on drawings.
8. Lining Material: Manufacturer's standard fabric for each use indicated.

D. Facing Material (AP-1): Fabric from same dye lot; color and pattern as indicated on Drawings.

1. Manufacturer: Wall Technology.
2. Product Line/Pattern: as indicated on drawings.
3. Pattern Repeat: as indicated on drawings.
4. Style Number: as indicated on drawings.
5. Color:as indicated on drawings.
6. Fiber Content: 100 percent acoustical vinyl.
7. Width: as indicated on drawings.

8. Lining Material: Manufacturer's standard fabric for each use indicated.

E. Mounting Devices: Concealed on back of panel, recommended by manufacturer to support weight of panel, and as follows:

1. Splines: Manufacturer's standard concealed metal or plastic splines that engage the kerfed edges of the panel, with other moldings and trim for interior corners, exterior corners, and exposed edges, with factory-applied finish on exposed items.
2. Adhesives: As recommended by fabric-wrapped, wall panel manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Metal Clips or Bar Hangers: Manufacturer's standard two-part metal "Z" clips, with one part of each clip mechanically attached to back of panel and the other part to substrate, designed to permit unit removal.

2.3 FABRICATION

A. General: Use manufacturer's standard construction except as otherwise indicated; with facing material applied to face, edges, and back border of dimensionally stable core; and with rigid edges to reinforce panel perimeter against warpage and damage.

B. Glass-Fiber Board Cores: Chemically harden core edges and areas of core where mounting devices are attached.

C. Core-Face Layer: Evenly stretched over core face and edges and securely attached to core; free from puckers, ripples, wrinkles, or sags.

D. Facing Material: Apply fabric fully covering visible surfaces of panel; with material stretched straight, on the grain, tight, square, and free from puckers, ripples, wrinkles, sags, blisters, seams, adhesive, or other visible distortions or foreign matter.

1. Square Corners: Tailor corners.
2. Radius and Other Nonsquare Corners: Attach material so there are no seams or gathering of material.
3. Fabrics with Directional or Repeating Patterns or Directional Weave: Mark fabric top and attach fabric in same direction so pattern or weave matches in adjacent panels.

E. Dimensional Tolerances of Finished Panels: Plus or minus 1/16 inch (1.6 mm) for the following:

1. Thickness.
2. Edge straightness.
3. Overall length and width.
4. Squareness from corner to corner.
5. Chords, radii, and diameters.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fabric, fabricated panels, substrates, areas, and conditions, for compliance with requirements, installation tolerances, and other conditions affecting performance of fabric-wrapped wall panels.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install fabric-wrapped wall panels in locations indicated with vertical surfaces and edges plumb, top edges level and in alignment with other panels, faces flush, and scribed to fit adjoining work accurately at borders and at penetrations.

B. Comply with fabric-wrapped, wall panel manufacturer's written instructions for installation of panels using type of mounting devices indicated. Mount panels securely to supporting substrate.

C. Align and level fabric pattern and grain among adjacent panels.

3.3 INSTALLATION TOLERANCES

A. Variation from Plumb and Level: Plus or minus 1/16 inch (1.6 mm).

B. Variation of Panel Joints from Hairline: Not more than 1/16 inch (1.6 mm) wide.

3.4 CLEANING

A. Clip loose threads; remove pills and extraneous materials.

B. Clean panels on completion of installation to remove dust and other foreign materials according to manufacturer's written instructions.

END OF SECTION 097723

SECTION 099100 - PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers

B. This Section includes surface preparation and the application of paint systems on the following exterior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Steel.
4. Galvanized metal.
5. Aluminum (not anodized or otherwise coated).
6. Wood.
7. Mechanical and electrical work (MEP)

C. Related Sections include the following:

1. Division 3 Sections "Concrete" for sealers of concrete flatwork.
2. Division 5 Sections for shop priming of metal substrates with primers specified in this Section.
3. Division 6 Sections for shop priming carpentry with primers specified in this Section.

1.3 ALTERNATE

A. Refer to Division 1 Section "ALTERNATES" for listing of Bid alternates that may affect the work described herein.

1.4 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Samples for Initial Selection: Upon request, for each type of topcoat product indicated.

D. Samples for Verification: For each type of paint system and each color and gloss of topcoat indicated.

1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
5. Label each sample as to date painted.

E. Product List: For each product indicated, include the following:

1 Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

1.5 QUALITY ASSURANCE

A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."

2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1.6 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 (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.7 PROJECT CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints 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.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents. Furnish an additional 2 percent, but not less than 1 gal. of each material and color applied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. Duron, Inc.
3. Finnaren & Haley Inc (F&H)
4. M.A.B. Paints.
5. Porter Paints.
6. PPG Architectural Finishes, Inc.
7. Sherwin-Williams Company
8. Thoro Systems waterproofing Inc

2.2 PAINT, GENERAL

A. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.

2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

B. VOC Content of Field-Applied Interior Paints and Coatings: Provide products that comply with the following limits for VOC content, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24); these requirements do not apply to paints and coatings that are applied in a fabrication or finishing shop:

1. Flat Paints, Coatings, and Primers: VOC content of not more than 50 g/L.
2. Non-flat Paints, Coatings, and Primers: VOC content of not more than 150 g/L.
3. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: VOC not more than 250 g/L.
4. Floor Coatings: VOC not more than 100 g/L.
5. Shellacs, Clear: VOC not more than 730 g/L.
6. Shellacs, Pigmented: VOC not more than 550 g/L.

C. Colors: Match Architect's samples or as indicated in a color schedule.

P-1: Sherwin Williams #SW 0051 Classic Ivory
P-2: Sherwin Williams #SW 2820 Downing Earth
P-3: Sherwin Williams #SW 6385 Dover White
P-4: Sherwin Williams #SW 2826 colonial revival Green Stone
P-5: Sherwin Williams #SW 0032 Needlepoint Navy
P-6: Sherwin Williams #SW 2813 Downing Straw

2.3 BLOCK FILLERS

A. Interior/Exterior Latex Block Filler: MPI #4.

1. VOC Content: E Range of E2.

B. Epoxy Block Filler: MPI #116.

1. VOC Content: E Range of E2.

2.4 PRIMERS/SEALERS

A. Alkali-Resistant Primer: MPI #3: Factory-formulated water based, alkali-resistant acrylic-latex interior primer for interior plaster applications.

1. VOC Content: E Range of E2.

B. Exterior Primer under Acrylic Finishes: Factory-formulated acrylic-based primer for exterior application. Provide breathable primer at masonry locations.

1. VOC Content: E Range of E2.
2. Benjamin Moore; Moore's IMC Acrylic Metal Primer No. M04: Applied at a dry film thickness of not less than 2.0 mils.
3. M. A. B. Paint; Rust-O-Lastic Hydro-Prime II Acrylic (DTM) Maintenance Primer 073-189: Applied at a dry film thickness of not less than 2.0 mils.

C. Interior Latex Primer/Sealer: MPI #50.

1. VOC Content: E Range of E2.
2. Environmental Performance Rating: EPR 2.

D. Interior Alkyd Primer/Sealer: MPI #45.

1. VOC Content: E Range of E2.

E. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

2.5 METAL PRIMERS

A. Alkyd Anticorrosive Metal Primer: MPI #79.

1. VOC Content: E Range of E2.

B. Waterborne Galvanized-Metal Primer: MPI #134.

1. VOC Content: E Range of E2.

C. Quick-Drying Primer for Aluminum: MPI #95.

1. VOC Content: E Range of E2.

D. Rust-Inhibitive Primer (Water Based): MPI #107.

1. VOC Content: E Range of E2.
2. Environmental Performance Rating: EPR 2.

E. Vinyl Wash Primer: MPI #80.

2.6 WOOD PRIMERS

A. Exterior Latex Wood Primer: MPI #6.

1. VOC Content: E Range of E2.

B. Exterior Alkyd Wood Primer: MPI #5.

1. VOC Content: E Range of E2.

C. Interior Latex-Based Wood Primer: MPI #39.

1. VOC Content: E Range of E2.
2. Environmental Performance Rating: EPR 2.

2.7 EPOXY PAINT

A. Water-Based Epoxy (Interior and Exterior): MPI #215. A water based, two component epoxy type, semi-gloss finish coating. Subject to compliance with requirements, provide one of the following:
   1. Benjamin Moore; M43/M44- 84 Acrylic Epoxy Semi-Gloss.
   2. M. A. B. Paint; Ply-Tile 530 Water-Reducible Acrylic Epoxy Semi-Gloss.

B. Water-Based Epoxy (Interior and Exterior): MPI #115. A water based, two component epoxy type, Gloss finish coating. Subject to compliance with requirements, provide one of the following:

   1. Benjamin Moore & Co.; Acrylic Epoxy Gloss "A", Hardener "B", M43/M44.
   2. ICI Paints; Devoe Coatings, Tru Glaze WB Epoxy Gloss Coating, 4408/4418
   3. Porter Paints; Dura-Glaze WB, Gloss Epoxy, 9371.
   4. PPG Architectural Finishes, Inc.; Aquapon, Waterborne Epoxy, 98-1/98-98.
   5. Sherwin-Williams Company (The); Industrial & Marine, Water Based Catalyzed Epoxy, B70W Series.

2.8 ALKYD PAINTS

A. Exterior Alkyd Enamel (Flat): MPI #8 (Gloss Level 1).

   1. VOC Content: E Range of E1.

B. Exterior Alkyd Enamel (Semi-gloss): MPI #94 (Gloss Level 5).

   1. VOC Content: E Range of E1.

C. Exterior Alkyd Enamel (Gloss): MPI #9 (Gloss Level 6).

   1. VOC Content: E Range of E1.

D. Interior Alkyd (Flat): MPI #49 (Gloss Level 1).

   1. VOC Content: E Range of E1.

E. Interior Alkyd (Eggshell): MPI #51 (Gloss Level 3).

   1. VOC Content: E Range of E1.

F. Interior Alkyd (Semi-gloss): MPI #47 (Gloss Level 5).

   1. VOC Content: E Range of E1.

G. Interior Alkyd (Gloss): MPI #48 (Gloss Level 6).

   1. VOC Content: E Range of E1.

2.9 ACRYLIC-RESIN COATING.

A. Breathable cement masonry paint formulated with colorfast pigments for use over cement plaster or masonry substrates. Include manufacturer's recommended primers. Coating shall be mildew resistant and breathable with perm rating of not less than 15 per ASTM E 96.

1. Thoro Products, "Thorosheen" or equal.
2. Primer: Thoroseal 1000.
3. Texture: smooth

2.10 LATEX PAINTS

A. Interior Latex (Flat): MPI #53 (Gloss Level 1).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 1.5.

B. Interior Latex (Low Sheen): MPI #44 (Gloss Level 2).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 2.

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

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 2.

D. Interior Latex (Satin): MPI #43 (Gloss Level 4).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 2.

E. Interior Latex (Semi-gloss): MPI #54 (Gloss Level 5).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 2.

F. Interior Latex (Gloss): MPI #114 (Gloss Level 6, except minimum gloss of 65 units at 60 deg).

1. VOC Content: E Range of E1.
2. Environmental Performance Rating: EPR 2.

G. Exterior Acrylic Latex (Flat): MPI #10 (Gloss Level 1).

1. VOC Content: E Range of E1.

H. Exterior Acrylic Latex (Semi-gloss): MPI #11 (Gloss Level 5).

1. VOC Content: E Range of E1.

2.11 DRY FOG/FALL COATINGS

A. Flat, Latex Dry Fog/Fall (MPI #118): Provide a water-based, emulsion-type, fast-drying coating used on overhead metal and other surfaces for application methods by airless and/or conventional spray equipment. Overspray will dry to a sweepable powder over a short distance for easier clean up.

1. VOC Content: E Range of E1.

B. Flat Dry-Fall for Galvanized Steel (water based) MPI # 133: Provide a waterborne coating, designed for direct application to cleaned, interior overhead galvanized metal surfaces, for application methods by airless and/or conventional spray equipment. Overspray will dry to a sweepable powder over a short distance for easier clean up.

1. VOC Content: E Range of E1.

2.12 FLOOR COATINGS

A. Interior/Exterior Clear Concrete Floor Sealer (Solvent Based): MPI #104.

1. VOC Content: E Range of E2.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Plaster: 12 percent.
5. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.

1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.

B. Remove plates, machined surfaces, and similar items already in place that are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

C. Clean substrates of substances that could impair bond of paints, including dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers as required to produce paint systems indicated.

2. Use abrasive blast-cleaning methods if recommended by paint manufacturer.

3. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.

4. Clean concrete floors to be painted with a 5 percent solution of muriatic acid or other etching cleaner. Flush the floor with clean water to remove acid, neutralize with ammonia, rinse, allow to dry, and vacuum before painting

D. Concrete Masonry Substrates: Remove 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. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer.

F. Ferrous Metals: Clean un-galvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's recommendations.

1. Blast steel surfaces clean as recommended by paint system manufacturer and according to SSPC-SP 6/NACE No. 3.
2. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
3. Touch up bare areas and shop-applied prime coats that have been damaged. Wire-brush, clean with solvents recommended by paint manufacturer, and touch up with same primer as the shop coat.

G. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

H. Wood Substrates:

1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Sand surfaces that will be exposed to view, and dust off.
3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

I. Plaster Substrates: Do not begin paint application until plaster is fully cured and dry.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions.

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions.

1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.

F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.

G. Overhead Structure and Exposed Ceiling Steel and Galvanized-Metal Substrates:

1. Prep substrate as required minimum. Repair existing primed surfaces.

2. Galvanized surface shall be prepared by either solvent cleaning and test for chromate passivation, with an SSPC SP 7 Brush-off blast cleaning if required or chemical-etching cleaners may be substituted for solvent washing and SSPC-SP 7 cleaning.

3. Apply primer coat to unprimed surfaces.

4. Paint exposed metal deck, structural steel, conduit, un-insulated ductwork and piping, and other mechanical and electrical work in finish and occupied rooms. Protect surfaces not to be painted. Dry-Fall painting shall not be required in mechanical-electrical equipment, custodial, storage and similar rooms.

H. Exterior Mechanical and Electrical Work: Painting of mechanical and electrical work is limited to items exposed on exterior of building, excluding roof mounted mechanical and electrical work. Items to be painted include, but are not limited to, the following:

1. Un-insulated metal and plastic piping, including hangers and supports.
2. Louvers, grilles, vents unless pre-finished.
3. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
4. Conduit and junction boxes.
5. Electrical equipment that is indicated to have a factory-primed finish for field painting.
6. Do not paint unless noted otherwise.
   a. Pre-finished mechanical equipment and items
   b. pipe and duct insulation
   c. Pre-finished electrical devices and/or cover plates
   d. Electrical fixtures
   e. Name places
   f. Moving parts
7. Touch up damaged finishes, including field applied and pre-finished surfaces.

I. **Interior Mechanical and Electrical Work**: Unless otherwise noted, painting of mechanical and electrical work is limited to items exposed to view in finished spaces as defined herein.
   1. Locations where MEP work to be field painted include following
      a. Occupied or Finish spaces are to include all rooms and other spaces with suspended, drywall or plaster ceiling, including toilet rooms and storage rooms. Also stairs, classroom and other rooms used by students
      b. Occupied or Finished Spaces with ceilings – Paint all exposed MEP work as described herein exposed to view.
      c. Occupied or Finished Spaces without ceilings - Paint all exposed MEP work as described herein exposed to view, including the structure above - unless noted otherwise.
      d. Occupied or Finished Spaces without ceilings (i.e., Egress Stairs, Gym, and Stage house), partial ceilings, and where indicated.
      e. Unless noted otherwise, painting of MEP work is not required of Unfinished or unoccupied spaces include mechanical and electrical equipment rooms (rooms whose primary purpose is to house HVAC or other MEP equipt), elevator equipment rooms, IT equipt and MDF rooms, storage rooms without finish ceilings, shafts and chases.

2. Items to be painted include, but are not limited to, the following:
   a. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
   b. Un-insulated metal and plastic piping
   c. Piping hangers and supports.
   d. Louvers grilles vents unless pre-finished
   e. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
   f. Electrical equipment that is indicated to have a factory-primed finish for field painting.
   g. Conduit and junction boxes, including metallic and PVC materials, fire alarm, BAS, attachments exposed and semi-exposed to view in finish areas
   h. Electrical and control panels in finish areas and exposed to view

3. Do not paint, unless noted otherwise.
   a. Pre-finished mechanical equipment and items
   b. pipe and duct insulation
   c. Pre-finished electrical devices and/or cover plates
   d. Electrical fixtures
   e. Name places
   f. Moving parts
   g. Sight exposed interior of ductwork and other equipment

4. Touch up damaged finishes, including field applied and pre-finished surfaces.

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 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.

3.5 EXTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System: MPI EXT 4.2A.

   a. Prime Coat: Interior/exterior latex block filler.
   b. Intermediate Coat: Exterior latex matching topcoat.

c. Topcoat: Exterior latex (semi-gloss).

2. Latex Over Alkali-Resistant Primer System: MPI EXT 4.2L.

a. Prime Coat: Alkali-resistant primer.
b. Intermediate Coat: Exterior latex matching topcoat.
c. Topcoat: Exterior latex (semi-gloss).

B. Galvanized-Metal Substrates:

1. Alkyd System: MPI EXT 5.3B.

a. Prime Coat: Cementitious galvanized-metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (semi-gloss).

C. Steel Substrates:

1. Alkyd System: MPI EXT 5.1D.

a. Prime Coat: Alkyd anticorrosive metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (Semi-gloss unless noted otherwise)

2. Alkyd System: MPI EXT 5.3B.

a. Prime Coat: Cementitious galvanized-metal primer.
b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
c. Topcoat: Exterior alkyd enamel (Semi-gloss unless noted otherwise)

3.6 INTERIOR PAINTING SCHEDULE

A. CMU Substrates:

1. Latex System: MPI INT 4.2A.
a. Prime Coat: Interior/exterior latex block filler.
b. Provide second coat of block filler at following locations:
1) All corridors
c. Intermediate Coat: Interior latex matching topcoat.
d. Topcoat: Interior latex (eggshell unless otherwise noted)

2. Water-Based Epoxy Coating System (Gloss):

a. Block Filler: 2 coats Epoxy block filler, MPI #116.
b. Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
c. Topcoat: Water-based epoxy (interior and exterior), MPI #115.

3. Water-Based Epoxy Coating System (Semi-Gloss):

a. Block Filler: 2 coats Epoxy block filler, MPI #116.
b. Intermediate Coat: Water-based epoxy (interior and exterior), MPI #115.
c. Topcoat: Water-based epoxy (interior and exterior), MPI #215.

B. Steel Substrates:

1. Alkyd System: MPI INT 5.1E.

a. Prime Coat: Quick-drying alkyd metal primer where required
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (Semi-gloss unless noted otherwise)

2. Water-Based Dry-Fall System: MPI INT 5.1C.

a. Prime Coat: Quick-drying alkyd metal primer where required.
b. Topcoat: Waterborne dry fall.

C. Galvanized-Metal Substrates:

1. Water-Based Dry-Fall System: MPI INT 5.3H.

a. Prime Coat: Waterborne dry fall where required
b. Topcoat: Waterborne dry fall.

2. Alkyd System: MPI INT 5.3C.

a. Prime Coat: Cementitious galvanized-metal primer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (Semi-gloss unless noted otherwise).

D. Wood Substrates, Traffic Surfaces: (Stage)

1. Alkyd Floor Enamel System: MPI INT 6.5A.

a. Prime Coat: Exterior/interior alkyd floor enamel
b. Intermediate Coat: Exterior/interior alkyd floor enamel (gloss).
c. Topcoat: Exterior/interior alkyd floor enamel (Gloss).

E. Dressed Lumber Substrates: Including architectural woodwork.

1. Latex System: MPI INT 6.3T.

a. Prime Coat: Interior latex-based wood primer.
b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex (semi-gloss).

F. Gypsum Board Substrates:

1. Latex System: MPI INT 9.2A.

a. Prime Coat: Interior latex primer/sealer

b. Intermediate Coat: Interior latex matching topcoat.
c. Topcoat: Interior latex. (Refer to finish schedule for gloss level.)

G. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings

1. Alkyd Over Latex Primer System: MPI INT 10.1B.

a. Prime Coat: Interior latex primer/sealer.
b. Intermediate Coat: Interior alkyd matching topcoat.
c. Topcoat: Interior alkyd (Flat)

END OF SECTION 099100

SECTION 101100 - VISUAL DISPLAY SURFACES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:
   1. Markerboards.(Whiteboards WB)

1.3 SUBMITTALS

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

B. LEED Submittal:

   1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
   2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

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

   1. Show location of panel joints.
   2. Include sections of typical trim members.

D. Samples for Initial Selection: For each type of visual display surface indicated and as follows:

   1. Color Selections for porcelain-enamel face sheet.
   2. Color selections for cork tack assemblies.
   3. Samples of accessories involving color selection.

E. Samples for Verification: For each type of visual display surface indicated and as follows:

1. Visual Display Surface: Not less than 8 by 10 inches, mounted on substrate indicated for final Work.
2. Cork Tack Surface: Not less that 8 by 10 inches of mounted on substrate indicated for final work

F. Maintenance Data: For visual display surfaces to include in maintenance manuals.

G. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain all visual display surface products through one source from a single manufacturer.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver factory-built visual display boards, including factory-applied trim where indicated, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.

B. Store visual display units vertically with packing materials between each unit.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer's standard form in which manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Surfaces lose original writing and erasing qualities.
   b. Surfaces become slick or shiny.
   c. Surfaces exhibit crazing, cracking, or flaking.

2. Warranty Period: Life of the building.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MARKERBOARD ASSEMBLIES (Whiteboards WB)

A. Porcelain-Enamel Markerboard Assembly: Factory assembled, balanced, high-pressure, factory-laminated markerboard assembly of 3-ply construction consisting of backing sheet, core material, and 24 gage porcelain-enamel face sheet.

B. Available Manufacturers:
   a. Claridge Products & Equipment, Inc.
   b. Egan Visual Inc.
   c. Ghent Manufacturing Inc.
   d. PolyVision Corporation.

C. Features and Accessories:

1. Face Sheet: LCD Liquid chalk writing surface with low gloss finish. 24 gage
2. Particleboard Core: 3/8 inch thick; with 0.015-inch thick, aluminum foil sheet backing.
3. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.
4. Accessories:

   a. Box type chalktray..
   b. Map rail with map hooks and clips length.
   c. flag holder.

5. Markerboard Assembly Color: As selected by Architect from full range of industry colors.
6. Trim: Aluminum trim with clear anodic finish, fabricated from not less than 0.062 inch thick extruded aluminum.

D. Size and Mounting

1. Width and Height: As scheduled and indicated on Drawings.
2. Mounting: Wall. Top of unit at 7’ 0” above finish floor.
3. Mounting: Wall. Top of unit at 7’ 0” above finish floor.

2.3 FABRICATION

A. Porcelain-Enamel Visual Display Assemblies: Laminate porcelain-enamel face sheet and backing sheet to core material under heat and pressure with manufacturer's standard flexible, waterproof adhesive.

B. Factory-Assembled Visual Display Units: Coordinate factory-assembled units with trim and accessories indicated. Join parts with a neat, precision fit.

1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
2. Provide manufacturer's standard mullion trim at joints between markerboards and tackboards of combination units.

C. Aluminum Frames and Trim: Fabricate units straight and of single lengths, keeping joints to a minimum. Miter corners to neat, hairline closure.

2.4 ALUMINUM 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. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

D. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance. Report (in writing) any conditions detrimental to performance of work.

B. Examine walls and partitions for proper backing for visual display surfaces.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Remove dirt, scaling paint, projections, and depressions that will affect smooth, finished surfaces of visual display boards.

3.3 INSTALLATION, GENERAL

A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.

B. Coordinate installation of tackboards (TB) and whiteboards (WB) with location of interactive white boards (IWB) as indicated.

3.4 INSTALLATION OF FACTORY-FABRICATED VISUAL DISPLAY UNITS

A. Visual Display Boards: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display boards with fasteners at not more than 16 inches o.c. Secure both top and bottom of boards to walls.

1. Field-Applied Aluminum Trim: Attach trim over edges of visual display boards and conceal grounds and clips. Attach trim to boards with fasteners at not more than 24 inches o.c.

a. Attach chalktrays to boards with fasteners at not more than 12 inches o.c.

3.5 CLEANING AND PROTECTION

A. Clean visual display surfaces according to manufacturer's written instructions. Attach one cleaning label to visual display surface in each room.

B. Touch up factory-applied finishes to restore damaged or soiled areas.

C. Cover and protect visual display surfaces after installation and cleaning.

4.0 SCHEDULE

A. Whiteboards (WB)

1. WB-1: 4’-0” H X 5’-0” W

END OF SECTION 101100

SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “Sustainable Design Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes composite units as follows:

1. Toilet Enclosures: Overhead braced.
2. Urinal Screens: Wall hung.
3. Shower Screens: Wall and floor braced.

B. Related Sections include the following:
1. Division 6, "Miscellaneous Carpentry
2. Division 10, "Toilet and Bath Accessories"

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

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

1. Show locations of cutouts for compartment-mounted toilet accessories.
2. Show locations of reinforcements for compartment-mounted grab bars.

D. Samples for Initial Selection:

1. Submit manufacturers color selection chart for selection.
2. Provide actual samples of panel material and hardware upon request.

1.4 QUALITY ASSURANCE

A. Purchase all toilet partition parts and accessories from a single manufacturer"

1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication and indicate measurements on Shop Drawings.

PART 2 - PRODUCTS

2.1 COMPOSITE UNITS

A. Manufacturers: Basis-of-Design: Bobrick, Sierra Series, Solid color reinforced composite.

B. Door, Panel, and Pilaster Construction: Solid, high-density polyethylene HDPE panel material, not less than 1 inch thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.

1. Color and Pattern: SC101 – Golden Khaki

C. Pilaster Shoes: Manufacturer's standard design; stainless steel.

D. Brackets (Fittings): Full-Height (Continuous) Type: Manufacturer's standard design; extruded aluminum.

E. Heat-Sink Strip: Manufacturer's standard continuous, extruded-aluminum strip fastened to exposed bottom edges of solid-polymer components to prevent burning.

2.2 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.

1. Material: Stainless steel – Type 304, with satin finish.

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 hardware, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use hot-dip galvanized or other rust-resistant, protective-coated steel.

2.3 FABRICATION

A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, fasteners, and anchors at pilasters to suit floor conditions. Make provisions for setting and securing continuous head rail at top of each pilaster. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Doors: Provide 36-inch doors with a minimum 32-inch- wide clear opening. See drawing for swing and other information.

1. Hinges: Manufacturer's standard self-closing type that can be adjusted to hold doors open at any angle up to 90 degrees.
   Full height (continuous) Stainless steel hinges
2. Latch and Keeper: Manufacturer's standard latch unit **DESIGNED FOR EMERGENCY ACCESS** and with combination rubber-faced door strike and keeper. Provide units that comply with accessibility requirements of authorities having jurisdiction at compartments indicated to be accessible to people with disabilities.
3. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent door from hitting compartment-mounted accessories.
4. Door Bumper: Manufacturer's standard rubber-tipped bumper.
5. Door Pull: Manufacturer's standard unit that complies with accessibility requirements of authorities having jurisdiction. Provide units on both sides of compartment doors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:

   a. Pilasters and Panels: 1/2 inch.
   b. Panels and Walls: 1 inch.

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Secure continuous head rail to each pilaster with not less 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. Wall-Hung Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb and to resist lateral impact.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open

approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113

SECTION 102226 - OPERABLE PARTITIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:
1. Electrically operated, acoustical panel partitions.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design operable panel partitions including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Operable panel partitions shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the panels will remain in place without separation of any parts from the assembly when subjected to the seismic forces specified."

C. Acoustical Performance: Provide operable panel partitions tested by a qualified testing agency for the following acoustical properties according to test methods indicated:

1. Sound-Transmission Requirements: Operable panel partition assembly tested for laboratory sound-transmission loss performance according to ASTM E 90, determined by ASTM E 413, and rated for not less than the STC indicated.
2. Acoustical Performance Requirements: Installed operable panel partition assembly, identical to partition tested for STC, tested for NIC according to ASTM E 336, determined by ASTM E 413, and rated for 10 dB less than STC value indicated.

1.4 SUBMITTALS

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

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

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

1. Indicate storage and operating clearances. Indicate location and installation requirements for hardware and track, blocking, and direction of travel.
2. Wiring Diagrams: For power, signal, and control wiring.

D. Samples: For each type of exposed material, finish, covering, or facing indicated.

E. Delegated-Design Submittal: For operable panel partitions indicated to comply with performance requirements, including analysis data and calculations signed and sealed by the qualified professional engineer responsible for their preparation.

F. Setting Drawings: For embedded items and cutouts required in other work, including support-beam, mounting-hole template.

G. Product certificates.

H. Product test reports.

I. Field quality-control reports.

J. Operation and maintenance data.

K. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.

B. Testing Agency Qualifications: Qualified according to Division 01 Section "Quality Requirements" for testing indicated.

C. Fire-Test-Response Characteristics: Provide panels with finishes meeting one of the following as determined by testing identical products by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Surface-Burning Characteristics: As determined by testing per ASTM E 84.

a. Flame-Spread Index: 25 or less.
b. Smoke-Developed Index: 450 or less.

2. Fire Growth Contribution: Meeting acceptance criteria of local code and authorities having jurisdiction when tested according to NFPA 265 NFPA 286.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Protectively package and sequence panels in order for installation. Clearly mark packages and panels with numbering system used on Shop Drawings. Do not use permanent markings on panels.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of operable panel partitions that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Steel Frame: Steel sheet, manufacturer's standard thickness.

B. Steel Face/Liner Sheets: Tension-leveled steel sheet, manufacturer's standard thickness.

C. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use, corrosion resistance, and finish indicated; manufacturer's standard strengths and thicknesses for type of use.

D. Wood Frame: Clear, vertical-grain, straight, kiln-dried, fire-retardant-treated wood; of manufacturer's standard species.

E. Gypsum Board: ASTM C 36/C 36M.

F. Cement Board: ASTM C 1288.

G. Plywood: DOC PS 1.

H. Particleboard: ANSI A208.1, made with binder containing no urea formaldehyde.

I. Medium-Density Fiberboard: ANSI A208.2, made with binder containing no urea formaldehyde.

2.2 OPERABLE ACOUSTICAL PANELS

A. Operable Acoustical Panels: Operable acoustical panel partition system, including panels, seals, finish facing, suspension system, operators, and accessories.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Modernfold, Acousti-Seal 933E or comparable product by one of the following:
      a. Hufcor.
      b. Panelfold Inc.

B. Panel Operation: Electrically operated, continuously hinged panels.

C. Panel Construction: Provide top reinforcement as required to support panel from suspension components and provide reinforcement for hardware attachment. Fabricate panels with tight hairline joints and concealed fasteners. Fabricate panels so finished in-place partition is rigid; level; plumb; aligned, with tight joints and uniform appearance; and free of bow, warp, twist, deformation, and surface and finish irregularities.

D. Dimensions: Fabricate operable acoustical panel partitions to form an assembled system of dimensions indicated and verified by field measurements.

E. STC: Not less than 52.

F. Panel Closure: Manufacturer's standard.

G. Hardware: Manufacturer's standard as required to operate operable panel partition and accessories; with decorative, protective finish.

2.3 SEALS

A. General: Provide types of seals indicated that produce operable panel partitions complying with acoustical performance requirements and the following:

   1. Manufacturer's standard seals.
   2. Seals made from materials and in profiles that minimize sound leakage.
   3. Seals fitting tight at contact surfaces and sealing continuously between adjacent panels and between operable panel partition perimeter and adjacent surfaces, when operable panel partition is extended and closed.

B. Horizontal Bottom Seals: PVC-faced, mechanical, retractable, constant-force-contact seal exerting uniform constant pressure on floor when extended, ensuring horizontal and vertical sealing and resisting panel movement.
   1. Automatically Operated for Acoustical Panels: Extension and retraction of bottom seal automatically operated by movement of partition, with operating range not less than 1 inch (25 mm) between retracted seal and floor finish.

2.4 FINISH FACING

A. General: Provide finish facings for panels that comply with indicated fire-test-response characteristics and that are factory applied to operable panel partitions with appropriate backing, using mildew-resistant nonstaining adhesive as recommended by facing manufacturer's written instructions.

1. Color/Pattern: As selected by Architect from manufacturer's full range.

B. Fabric Wall Covering: Manufacturer's standard fabric from same dye lot, treated to resist stains.

C. Trimless Edges: Fabricate exposed panel edges so finish facing wraps uninterrupted around panel, covering edge and resulting in an installed partition with facing visible on vertical panel edges, without trim, for minimal sightlines at panel-to-panel joints.

2.5 SUSPENSION SYSTEMS

A. Suspension Tracks: Steel or aluminum mounted directly to overhead structural support, with adjustable steel hanger rods for overhead support, designed for type of operation, size, and weight of operable panel partition indicated. Size track to support partition operation and storage without damage to suspension system, operable panel partitions, or adjacent construction. Limit track deflection to no more than 0.10 inch (2.54 mm) between bracket supports. Provide a continuous system of track sections and accessories to accommodate configuration and layout indicated for partition operation and storage.

B. Carriers: Trolley system as required for configuration type, size, and weight of partition and for easy operation; with ball-bearing wheels.

C. Track Intersections, Switches, and Accessories: As required for type of operation, storage, track configuration, and layout indicated for operable panel partitions, and compatible with partition assembly specified. Fabricate track intersections and switches from steel or aluminum.

D. Aluminum Finish: Mill finish or manufacturer's standard, factory-applied, decorative finish unless otherwise indicated.

E. Steel Finish: Manufacturer's standard, factory-applied, corrosion-resistant, protective coating unless otherwise indicated.

2.6 ELECTRIC OPERATORS

A. General: Provide factory-assembled electric operation system of size and capacity recommended and provided by operable panel partition manufacturer for partition specified; with electric motor and factory-prewired motor controls, speed reducer, chain drive, remote-control stations, control devices, and accessories required for proper operation. Include wiring from motor control to motor. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

B. Comply with NFPA 70.

C. Control Equipment: Complying with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6.

D. Motor Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, within installed environment, with indicated operating sequence, and without exceeding nameplate rating or considering service factor. Comply with NEMA MG 1.

E. Remote-Control Stations: Two single-key-operated, constant-pressure control stations located remotely from each other on opposite sides and opposite ends of partition run. Wire in series to require simultaneous activation of both key stations to operate partition. Each three-position control station labeled "Open," "Close," and "Stop." Provide two keys per station.

F. Obstruction-Detection Devices: Provide each motorized operable panel partition with automatic safety sensor that causes operator to immediately stop and reverse direction.

G. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop operable panel partition at fully extended and fully stacked positions.

H. Emergency Release Mechanism: Quick disconnect-release of electric-motor drive system, permitting manual operation in event of operating failure.

2.7 ACCESSORIES

A. Pass Doors: Fabricated to comply with recommendations in ICC/ANSI A117.1 the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines. Swinging door built into and matching panel materials, construction, acoustical qualities, fire rating finish, and thickness, complete with frames and operating hardware. Hinges finished to match other exposed hardware.

1. Single Pass Door: 36 by 84 inches (914 by 2134 mm), with the following:

    a. Door Seals: Mechanically operated floor seal on panels containing pass doors.
    b. Concealed door closer.
    c. Latchset: Passage set.

B. Storage Pocket Door: Full height at end of partition runs to conceal stacked partition; of same materials, finish, construction, thickness, and acoustical qualities as panels; complete with operating hardware and acoustical seals at soffit, floor, and jambs. Hinges in finish to match other exposed hardware.

1. Type II double door hinged to jamb on each side and closing in the center.

C. Electric Interlock: Provide each motorized operable panel partition with electric interlocks at locations indicated, to prevent operation of operable panel partition under the following conditions:

1. On storage pocket door, to prevent operation if door is not in fully open position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General: Comply with ASTM E 557 except as otherwise required by operable panel partition manufacturer's written installation instructions.

B. Install operable panel partitions and accessories after other finishing operations, including painting, have been completed.

C. Install panels from marked packages in numbered sequence indicated on Shop Drawings.

D. Broken, cracked, chipped, deformed, or unmatched panels are not acceptable.

E. Broken, cracked, deformed, or unmatched gasketing or gasketing with gaps at butted ends is not acceptable.

3.2 ADJUSTING

A. Adjust operable panel partitions to operate smoothly, without warping or binding. Lubricate hardware, electric operator, and other moving parts.

B. Adjust pass doors and storage pocket doors to operate smoothly and easily, without binding or warping. Check and readjust operating hardware. Confirm that latches and locks engage accurately and securely without forcing or binding.

3.3 FIELD QUALITY CONTROL

A. Light-Leakage Test: Illuminate one side of partition installation and observe vertical joints and top and bottom seals for voids; adjust partitions for acceptable fit.

B. Repair or replace operable panel partitions that do not comply with requirements.

C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of repaired, replaced, or additional work with specified requirements.

D. Prepare test and inspection reports.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain operable panel partitions.

END OF SECTION 083514

SECTION 102800 – TOILET, BATH AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “Sustainable Design Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Toilet and bath accessories.
2. Under lavatory guards.

B. Related Sections include the following:
1. Division 10 Section "Toilet Compartments" for compartments and screens.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use designations indicated in the Toilet and Bath Accessory Schedule and room designations as indicated on Drawings in product schedule.

D. Maintenance Data: For accessories to include in maintenance manuals specified in Division 1. Provide lists of replacement parts and service recommendations.

1.4 QUALITY ASSURANCE

A. Source Limitations: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by Architect.

1. Products of other manufacturers with equal characteristics, as judged solely by Architect, may be provided.
2. Other manufacturers' products with equal characteristics may be considered. See Division 1 Section "Substitutions."
3. Do not modify aesthetic effects, as judged solely by Architect, except with Architect's approval. Where modifications are proposed, submit comprehensive explanatory data to Architect for review.

1.5 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, 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.

1.6 WARRANTY

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

B. Manufacturer's Mirror Warranty: Written warranty, executed by mirror manufacturer agreeing to replace mirrors that develop visible silver spoilage defects within minimum warranty period indicated.

1. Minimum Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide accessories by one of the following:

1. Toilet and Bath Accessories:

a. A & J Washroom Accessories, Inc.
b. American Specialties, Inc.
c. Bobrick Washroom Equipment, Inc.
d. Bradley Corporation.

2.2 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch (0.8-mm) minimum nominal thickness, unless otherwise indicated.

B. Brass: ASTM B 19, leaded and unleaded flat products; ASTM B 16 (ASTM B 16M), rods, shapes, forgings, and flat products with finished edges; ASTM B 30, castings.

C. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch (0.9-mm) minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.

D. Galvanized Steel Sheet: ASTM A 653/A 653M, G60 (Z180).

E. Mirror Glass: ASTM C 1036, Type I, Class 1, Quality q2, nominal 6.0 mm thick, with silvering, electroplated copper coating, and protective organic coating complying with FS DD-M-411.

F. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

G. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.3 FABRICATION

A. General: One, maximum 1-1/2-inch diameter, unobtrusive stamped manufacturer logo, as approved by Architect, is permitted on exposed face of accessories. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.

B. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.

C. Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.

D. Framed Glass-Mirror Units: Fabricate frames for glass-mirror units to accommodate glass edge protection material. Provide mirror backing and support system that permits rigid, tamper-resistant glass installation and prevents moisture accumulation.

1. Provide galvanized steel backing sheet, not less than 0.034 inch and full mirror size, with nonabsorptive filler material. Corrugated cardboard is not an acceptable filler material.

E. Mirror-Unit Hangers: Provide mirror-unit mounting system that permits rigid, tamper- and theft-resistant installation, as follows:

1. Heavy-duty wall brackets of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.

F. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

2.4 UNDERLAVATORY GUARDS

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. Plumberex Specialty Products, Inc.
2. TCI Products
3. Truebro Inc.

B. Underlavatory Guard:

1. Description: Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping; allow service access without removing coverings.
2. Material and Finish: Antimicrobial, molded plastic, white.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Secure mirrors to walls in concealed, tamper-resistant manner with special hangers, toggle bolts, or screws. Set units level, plumb, and square at locations indicated, according to manufacturer's written instructions for substrate indicated.

C. Install grab bars to withstand a downward load of at least 250 lbs., when tested according to method in ASTM F 446.

3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

3.3 TOILET AND BATH ACCESSORY SCHEDULE

Basis-of-Design Product: The design for the product identified is based on the product named.

The use of a trade name and/or suppliers name and address in the specifications is to indicate a possible source of the product and a standard of quality. Products of the same type from other sources shall not be excluded, provided they possess like physical and functional and aesthetic characteristics Other manufacturers listed in this specification section may be substituted if they meet all design criteria. The identification numbers are cross referenced with the Drawings. See A103.

END OF SECTION 102800

SECTION 104400 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Portable fire extinguishers.
2. Fire extinguishers cabinets
3. Mounting brackets for fire extinguishers.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection cabinets.

1. Fire Extinguishers: Include rating and classification.
2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, and cabinet type, trim style, and panel style.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Maintenance Data: For fire extinguishers to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets each through one source from a single manufacturer.

B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction. Provide fire extinguishers approved, listed, and labeled by FMG.

D. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.

1.5 COORDINATION

A. Coordinate installation of fire valve cabinets with fire protection contractor. Fire valve to be installed at correct height for proper mounting of cabinet. Verify proper knockout size and location.

B. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Failure of hydrostatic test according to NFPA 10.
b. Faulty operation of valves or release levers.

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

PART 2 - PRODUCTS

2.1 CABINET MANUFACTURERS

A. Basis-of-Design Product: The design for each product is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

1. J. L. Industries
2. Johnson-Lee, Division of W. F. Lee Corporation
3. Modern Metal Products

4. Muckel Manufacturing, Division of Technico, Inc.
5. Larsen's Manufacturing Company
6. Watrous, Inc.

2.2 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.3 PORTABLE FIRE EXTINGUISHERS

A. Available Manufacturers:
1. Ansul Incorporated.
2. JL Industries, Inc.
3. Kidde Fyrnetics.
4. Larsen's Manufacturing Company.
5. Modern Metal Products; Div. of Technico.
6. Potter Roemer; Div. of Smith Industries, Inc.

B. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.

1. Valves: Manufacturer's standard.
2. Handles and Levers: Manufacturer's standard.
3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

C. Multipurpose Dry-Chemical Type in cabinet or bracket: UL-rated 4A, 60 BC, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container with indicating gage and hose.

D. Wet-Chemical Type in kitchen and where indicated: UL #10 rated 2-A:1-B:C:K, 1.6-gal. nominal capacity, with potassium acetate based chemical in stainless-steel container; with pressure-indicating gage and hose.

2.4 FIRE-PROTECTION CABINETS

A. Cabinets to be semi-recessed or recessed, streamline, vision-lite door with 180 degree hinge, unit with vertical vision-lite indoor, unless otherwise scheduled. Sized for 2-1/2 gallon 24-1/2" x 7" diameter) extinguisher.

B. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated. Weld joints and grind

smooth. Provide factory-drilled mounting holes. Where indicated or required to suit field conditions provide cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).

C. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick. Miter and weld perimeter door frames. **Provide with Manufacturer's fully recessed door-operating hardware of proper type for cabinet type.**

D. Door Glazing to be vertical lite similar to Lawson “Vertical-Duo” Lite with clear **tempered** float glass.

E. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

F. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
1. Recessed door pull and friction latch
2. Continuous hinges of same material and finish as trim. Manufacturer's standard hinge - permitting door to open 180 degree.

G. Fire valve cabinets: Prior to fabrication, verify knockout location with fire protection contractor,

H. Fire-Rated Cabinets: Cabinets indicated with suffix “FR” to be fire-rated cabinets with double walls minimum 5/8-inch thick, fire-barrier material. Provide factory-drilled mounting holes. Provide rated cabinet where required to maintain fire rating of wall assembly

I. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Glass-mounted decal to be vertical vinyl red lettering. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in vertical red letter decals applied to mounting surface.

2.5 FINISHES, GENERAL

A. Comply with Name’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. Finish fire-protection cabinets after assembly.

D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are

acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.6 STEEL FINISHES

A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

B. Stainless Steel: No. 4 finish

2.7 SCHEDULE of FIRE-PROTECTION SPECIALTIES

Note: All cabinets to be provided with fire extinguisher. Coordinate with wall types.

FEC #1: **Semi-Recessed Fire Extinguisher Cabinet.** Basis of design: Larsen Architectural **2712-RA** (4 inch). Rolled-Edge Trim: 4-inch backbend depth unless otherwise required. **Furnish with recess latching handle (typical all FEC).** Minimum recess depth: 4.5 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed cabinets will be installed. Examine fire extinguishers for proper charging and tagging. Remove and replace damaged, defective, or undercharged units. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Prepare recesses for recessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire-protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi-recessed fire-protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

C. Identification: Apply vinyl lettering at locations indicated.

D. Mounting height: Recessed and semi-recessed cabinets to be 56" (verify) to top of rough-in opening above finish floor.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.

E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104400

SECTION 108200 GRILLES AND SCREENS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Fixed, extruded-aluminum screen w/horizontal inverted J-blades.

B. Related Sections include the following:

1. Division 7 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.
2. Division 8 Section "Steel Doors and Frames
3. Division 15 for mechanical ductwork

1.3 DEFINITIONS

A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. 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.

1.4 PERFORMANCE REQUIREMENTS

A. Structural Performance: Provide louvers capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act on vertical projection of louvers.

1. Wind Loads: Determine loads based on pressures as indicated on Drawings.

B. Thermal Movements: Provide louvers 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 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 (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Air-Performance, Water-Penetration, Air-Leakage, and Wind-Driven Rain Ratings: Provide louvers complying with performance requirements indicated, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other Work. Show blade profiles, angles, and spacing.

D. Samples
1. Submit manufacturers color selection chart for selection.
2. Samples for Verification: Upon request, Provide actual samples for each type of metal finish required.
3. Construction Samples Upon request Provide actual samples of louver and frame construction

E. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain louvers and vents through one source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.2, "Structural Welding Code--Aluminum."

C. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify louver openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish opening dimensions and proceed with fabricating louvers without field measurements. Coordinate construction to ensure that actual opening dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design: All-Lite, Model HJ-445

1. Material: 6063-T5 extruded aluminum.
2. Frame: 2” x 1 ½” x 0.081” thick angle.
3. Blades: 45^{o} x 0.081” thick J-style
4. Mullion: Visible

2.2 MATERIALS

A. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

C. Aluminum Castings: ASTM B 26/B 26M, alloy 319.

D. Fasteners: Of same basic metal and alloy as fastened metal or 300 Series stainless steel, unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Use Phillips flat-head screws for exposed fasteners, unless otherwise indicated.

E. 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 per ASTM E 488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.

2.3 FABRICATION, GENERAL

A. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.

1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated

C. Maintain equal louver blade spacing to produce uniform appearance.

D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

1. Frame Type: Channel unless otherwise indicated.

E. Include supports, anchorages, and accessories required for complete assembly.

F. Provide concealed vertical mullions of type and at spacings indicated, but not more than recommended by manufacturer, or 72 inches (1830 mm) o.c., whichever is less.
1. Semirecessed Mullions: Where indicated, provide mullions partly recessed behind louver blades so louver blades appear continuous. Where length of louver exceeds fabrication and handling limitations, fabricate with interlocking split mullions and close-fitting blade splices designed to permit expansion and contraction.
2. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
3. Exterior Corners: Prefabricated corner units with mitered and welded blades mitered blades with concealed close-fitting splices and with fully recessed semirecessed mullions at corners.

G. Provide extended subsills made of same material as louvers unless otherwise indicated..

H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, concealed from view, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

2.4 FINISHES, GENERAL

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

B. Finish louvers after assembly.

2.5 ALUMINUM FINISHES

A. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.

B. High-Performance Organic-Coating Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Fluoropolymer Two-Coat Coating System: 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; complying with AAMA 2605.
   a. Color and Gloss: Custom color to match Architect’s sample.

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.

1. 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.

B. Coordinate with mechanical contractor work including ductwork, dampers, operators, insulation, blank-off panels and other items to interface with louvers.

3.3 INSTALLATION

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

F. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

G. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Division 7 Section "Joint Sealants" for sealants applied during louver installation.

3.4 ADJUSTING AND CLEANING

A. Clean exposed surfaces of louvers and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate until final cleaning.

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 and vents 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 108200

SECTION 109990 – MISCELLANEOUS SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes miscellaneous specialty items where shown on the drawings. They include:

1. Bike Rack
2. High Security Commercial Key Box

B. Basis-of-Design Product: The design for the product(s) identified is based on the product named. The use of a trade name and/or suppliers name and address in the specifications is to indicate a possible source of the product and a standard of quality. Products of the same type from other sources shall not be excluded, provided they possess like physical and functional and aesthetic characteristics. Refer to Division 1, "Product Requirements" for process to obtain approval of other products.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of the Contract and Division 1 Specification Sections.

B. Product data for each specialty, component and installation accessory required, including installation methods for each type of substrate. Include details of construction, dimensions, profiles, component parts, accessories, finishes, and installation instructions. Provide complete operating and maintenance instructions. Provide written data on each required component including physical characteristics, such as durability, resistance to fading, and flame resistance.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

D. Shop drawings showing locations, extent, and installation details of items. Show methods of attachment to adjoining construction.

E. Samples upon request

F. Test reports from qualified independent testing laboratory evidencing compliance with standards listed herein shall be provided where required or upon Architect's request. Include testing laboratory's analysis of results.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has previously installed systems similar in material, design, and extent to the systems indicated for this Project.

B. Manufacturer Qualifications: Firm experienced in manufacturing items that are similar to those required for this Project and that have a record of successful in-service performance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver items to Project site in original factory wrappings and containers, clearly labeled with identification of manufacturer, brand name, quality or grade, and fire hazard classification.

B. Store materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

C. Maintain room temperature within the storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored. Keep sheet material out of direct sunlight to avoid surface distortion.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Do not install components until the space is enclosed and weatherproof and until the ambient temperature within the building is maintained at not less than 70 deg F (21 deg C) for not less than 72 hours prior to beginning of the installation. Do not install systems until that temperature has been attained and is stabilized.

1.7 MAINTENANCE

A. Maintenance Instructions: Provide the manufacturer's instructions for maintenance of installed work. Include recommended methods and frequency for maintaining optimum condition under anticipated traffic and use conditions. Include precautions against cleaning materials and methods that may be detrimental to finishes and performance.

PART 2 – PRODUCTS

A. Bicycle Racks: Provide tubular stainless steel loop type bicycle rack, surface mounted construct of nominal 2 3/8” o.d. schedule 40 stainless steel pipe or tube with predrilled s.s. surface

mounting flange. Installed height: nominal 36" above finish floor. Capacity: 9 bicycles (7 Loop). Finish satin (#3 or #4). Provide units, which comply with requirements as manufactured the following or approved equal:

1. Original Cycloops, model 2170-9-S; Columbia Cascade Co., Portland Oregon (800) 547-1940, (503) 223-1157.
2. Heavy Duty Winder, model HW238-9SF-s; Madrax, Inc. Middletown Wisc., (800) 448-7931, (608) 831-9040.
3. Dero Bike Rack Co., model RR4H, Minneapolis, MN (888) 337-6729.

B. High Security Commercial Key Bos: Provide Knox-Box 3200 Series with hinged door, by Knox Company6, or approved equivalent.

1. Recessed Mount

PART 3 - EXECUTION

3.1 GENERAL:

A. Comply with manufacturer's instructions and recommendations.
B. Coordinate location, cutout sizes, and rough-in with adjacent work. Review and verify that shop drawings for custom casework, doors and similar work prior to fabrication. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
C. Built-In Equipment: Securely anchor units to supporting cabinets or countertops with concealed fasteners.
D. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate to properly operate equipment.

3.2 **INSTALLATION**

A. Install miscellaneous specialties at locations shown in accordance with manufacturer's instructions for plumb, level, rigid, and flush installation.

B. Securely anchor to substrate(s). Provide solid blocking at all locations. Protect from damage. Secure lockers and other specialties to adjacent substrate per manufacturer's recommendations

C. Install trim, items, using manufacturer's anchors or concealed fasteners. Provide flush, hairline joints against adjacent surfaces

D. Verify that accessory items required have been furnished and installed.

3.3 ADJUST AND CLEAN

A. Adjust units after installation to ensure that units are level and that moving parts operate freely and in manner intended. Clean exposed surfaces and touch-up or replace damaged marred finishes..

B. Touch-up marred finishes, but replace units that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished manufacturer.

END OF SECTION 109990

SECTION 122413 - ROLLER SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “LEED Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes roller shades and motorized shade operators.

B. Related Sections include the following:

1. Division 5 Section "Ornamental Metal" for custom metal pockets for window treatments fabricated from metal extrusions.

2. Division 5 Section "Ornamental Formed Metal" for custom sheet metal pockets for window treatments.

3. Division 6 Section "Miscellaneous Carpentry" for wood blocking and grounds for mounting roller shades and accessories.

4. Division 16 Sections for electrical service and connections for motor operators, controls, limit switches, and other powered devices and for system disconnect switches for motorized shade operation.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions.

1. Motorized Shade Operators: Include operating instructions.

2. Motors: Show nameplate data, ratings, characteristics, and mounting arrangements.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of

postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

C. Shop Drawings: Show location and extent of roller shades. Include elevations, sections, details, and dimensions not shown in Product Data. Show installation details, mountings, attachments to other work, operational clearances, and relationship to adjoining work.

1. Motorized Shade Operators: Show locations and details for installing operator components, switches, and controls. Indicate motor size, electrical characteristics, drive arrangement, mounting, and grounding provisions.

2. Wiring Diagrams: Power, system, and control wiring.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension system members and attachment to building structure.
2. Ceiling-mounted or penetrating items including light fixtures, air outlets and inlets, speakers, sprinklers, recessed shades, and special moldings at walls, column penetrations, and other junctures of acoustical ceilings with adjoining construction.
3. Shade mounting assembly and attachment.
4. Size and location of access to shade operator and adjustable components.
5. Minimum Drawing Scale: 1/8 inch = 1 foot (1:96).

E. Samples for Initial Selection: For each colored component of each type of shade indicated.

1. Include similar samples of accessories involving color selection.

F. Samples for Verification:

1. Complete, full-size operating unit not less than 16 inches (400 mm) wide for each type of roller shade indicated.

2. For the following products:

a. Shade Material: Not less than 3 inches (76 mm) square, with specified treatments applied. Mark face of material.

b. Shade Material: Not less than 12-inch- (300-mm-) square section of fabric, from dye lot used for the Work, with specified treatments applied. Show complete pattern repeat. Mark top and face of material.

c. Valance: Full-size unit, not less than 12 inches (300 mm) long.

G. Window Treatment Schedule: For roller shades. Use same designations indicated on Drawings.

H. Product Certificates: For each type of roller shade, signed by product manufacturer.

I. Qualification Data: For Installer.

J. Product Test Reports: For each type of roller shade.

K. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of roller shade.

L. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:

1. Methods for maintaining roller shades and finishes.
2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
3. Operating hardware.
4. Motorized shade operator.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Source Limitations: Obtain roller shades through one source from a single manufacturer.

C. Fire-Test-Response Characteristics: Provide roller shade band materials with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:

1. Flame-Resistance Ratings: Passes NFPA 701.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Product Standard: Provide roller shades complying with WCMA A 100.1.

F. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver shades in factory packages, marked with manufacturer and product name, fire-test-response characteristics, lead-free designation, and location of installation using same designations indicated on Drawings and in a window treatment schedule.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and wet and dirty finish work in spaces, including painting, is complete 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 operable glazed units' operation hardware throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Rollers Shades: Before installation begins, for each size, color, texture, and pattern indicated, full-size units equal to 5 percent of amount installed.

PART 2 - PRODUCTS

2.1 ROLLER SHADES – RS-1

A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc; Mecho/5 Doubleshade System, Vertical Style with Snap Loc Fascia or a comparable product by one of the following:

1. Draper Inc.
2. Hunter Douglas, Inc., Contract
3. Lutron Shading Solutions by VIMCO.

B. Shade Band Material: Opaque Vinyl/Vinyl and Woven FR Vinyl.

1. Fabric Width: As required to cover window without vertical seams.
2. Pattern: Visually Opaque Vinyl/Vinyl Shadecloth – Thermoveil 0700 Series Room Darkening Shadecloth; and visually transparent single-fabric shadecloth Eurotwill 6000 Series.
3. Style: Opaque Vinyl/Vinyl and Transparent Open Basket Weave.
4. Colors: To be selected from standard finishes.
5. Material Openness Factor: 5 percent and 0 percent.
6. Bottom Hem: Straight.
7. Trim: As indicated by manufacturer's designation for style and color.

C. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide

capacity for two roller shade band(s) per roller, unless otherwise indicated in a window treatment schedule.

D. Direction of Roll: Regular, from back of roller, and reverse, from front of roller, as indicated on Drawings for double-roller shades.

E. Mounting Brackets: Galvanized or zinc-plated steel.

F. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated in a window treatment schedule; removable design for access. Recessed mounted.

G. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

H. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.

I. Bottom Bar: Steel or extruded aluminum. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

J. Mounting: As indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

K. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard for anchoring roller shade bottom in place and keeping shade band material taut.

L. Shade Operation: Manual; with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.

1. Position of Clutch Operator: Right side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated in a window treatment schedule.
2. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
3. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
4. Loop Length: Length required to make operation convenient from floor level.
5. Bead Chain: Stainless steel.
6. Operating Function: Stop and hold shade at any position in ascending or descending travel.

2.2 ROLLER SHADES – RS-2

A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc; Mecho/5 Doubleshade System, Vertical Style with Snap Loc Fascia or a

comparable product by one of the following:

1. Draper Inc.
2. Hunter Douglas, Inc., Contract.
3. Lutron Shading Solutions by VIMCO.

B. Shade Band Material: Opaque Vinyl/Vinyl and Woven FR Vinyl.

1. Fabric Width: As required to cover window without vertical seams.
2. Pattern: Visually Opaque Vinyl/Vinyl Shadecloth – Thermoveil 0700 Series Room Darkening Shadecloth; and visually transparent single-fabric shadecloth Eurotwill 6000 Series.
3. Style: Opaque Vinyl/Vinyl and Transparent Open Basket Weave.
4. Colors: To be selected from standard finishes.
5. Material Openness Factor: 5 percent and 0 percent.
6. Bottom Hem: Straight.
7. Trim: As indicated by manufacturer's designation for style and color.

C. Rollers: Electrogalvanized or epoxy primed steel or extruded-aluminum tube of diameter and wall thickness required to support and fit internal components of operating system and the weight and width of shade band material without sagging; designed to be easily removable from support brackets; with manufacturer's standard method for attaching shade material. Provide capacity for two roller shade band(s) per roller, unless otherwise indicated in a window treatment schedule.

D. Direction of Roll: Regular, from back of roller, and reverse, from front of roller, as indicated on Drawings for double-roller shades.

E. Mounting Brackets: Galvanized or zinc-plated steel.

F. Fascia: L-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; continuous panel concealing front and bottom of shade roller, brackets, and operating hardware and operators; length as indicated in a window treatment schedule; removable design for access. Surface mounted.

G. Fascia End Caps: 18” (3mm) thick sheet steel wall or jamb mounted. Material and finish to match fascia.

H. Top/Back Cover: L-shaped; material and finish to match fascia; combining with fascia and end caps to form a six-sided headbox enclosure sized to fit shade roller and operating hardware inside.

I. Pocket-Style Headbox: U-shaped, formed-steel sheet or extruded aluminum; long edges returned or rolled; with a bottom cover consisting of slot opening of minimum dimension to allow lowering and raising of shade and a removable or an openable, continuous metal access panel concealing shade roller, brackets, and operating hardware and operators within.

J. Bottom Bar: Steel or extruded aluminum. Provide concealed, by pocket of shade material, internal-type bottom bar with concealed weight bar as required for smooth, properly balanced shade operation.

K. Mounting: As indicated on Drawings, mounting permitting easy removal and replacement without damaging roller shade or adjacent surfaces and finishes.

L. Hold-Down Brackets and Hooks or Pins: Manufacturer's standard for anchoring roller shade bottom in place and keeping shade band material taut.

M. Shade Operation: Manual; with continuous-loop bead-chain, clutch, and cord tensioner and bracket lift operator.

1. Position of Clutch Operator: Right side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated in a window treatment schedule.
2. Clutch: Capacity to lift size and weight of shade; sized to fit roller or provide adaptor.
3. Lift-Assist Mechanism: Manufacturer's standard spring assist for balancing roller shade weight and lifting heavy roller shades.
4. Loop Length: Custom length to make operation convenient from window header height at 13’0” – 14’ 0” +/- to operate at floor level (see Section2/A311).
5. Bead Chain: Stainless steel.
6. Operating Function: Stop and hold shade at any position in ascending or descending travel.

2.3 ROLLER SHADE FABRICATION

A. Product Description: Roller shade consisting of a roller, a means of supporting the roller, a flexible sheet or band of material carried by the roller, a means of attaching the material to the roller, a bottom bar, and an operating mechanism that lifts and lowers the shade.

B. Concealed Components: Noncorrodible or corrosion-resistant-coated materials.

1. Lifting Mechanism: With permanently lubricated moving parts.

C. Unit Sizes: Obtain units fabricated in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):

1. Shade Units Installed between (Inside) Jambs: Edge of shade not more than 1/4 inch (6 mm) from face of jamb. Length equal to head to sill dimension of opening in which each shade is installed.

2. Shade Units Installed Outside Jambs: 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.

D. Installation Brackets: Designed for easy removal and reinstallation of shade, for supporting fascia, roller, and operating hardware and for hardware position and shade mounting method indicated.

E. Installation Fasteners: No fewer than two fasteners per bracket, fabricated from metal noncorrosive to shade hardware and adjoining construction; type designed for securing to supporting substrate; and supporting shades and accessories under conditions of normal use.

F. Color-Coated Finish: For metal components exposed to view, apply manufacturer's standard baked finish complying with manufacturer's written instructions for surface preparation including pretreatment, application, baking, and minimum dry film thickness.

G. Colors of Metal and Plastic Components Exposed to View: As selected by Architect from manufacturer's full range, unless otherwise indicated.

2.4 MOTORIZED ROLLER SHADE OPERATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide MechoShade Systems, Inc.; Electroshade Doubleshade Electro / 2 #17 Motorized Roller Screen System with Snap Loc Fascia or a comparable product by one of the following:

1. Manufacturer of roller shade.
2. Elero USA Inc.
3. SIMU US, Inc.
4. SOMFY Systems.

B. General: Provide factory-assembled motorized shade operation systems designed for lifting shades of type, size, weight, construction, use, and operation frequency indicated. Provide operation systems of size and capacity and with features, characteristics, and accessories suitable for Project conditions and recommended by shade manufacturer, complete with electric motors and factory-prewired motor controls, remote-control stations, remote-control devices, power disconnect switches, enclosures protecting controls and all 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 the building electrical system.

C. Comply with NFPA 70.

D. Control Equipment: Comply with NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6 with NFPA 70, Class 2 control circuit, maximum 24-V ac or dc.

E. Electric Motors: UL-approved or -recognized, totally enclosed, insulated motor, complying with NEMA MG 1, with thermal-overload protection, brake, permanently lubricated bearings, and limit switches; sized by shade manufacturer to start and operate size and weight of shade considering service factor or considering Project's service conditions without exceeding nameplate ratings.

1. Service Factor: According to NEMA MG 1, unless otherwise indicated.
2. Motor Characteristics: Single phase, 110 V, 60 Hz, Temperature Class A, thermally protected, equipped with locking disconnect plug assembly furnished with each motor.
3. Motor Mounting: Within manufacturer's standard roller enclosure.

F. Position of Motor and Electrical Connection: Right side of roller, as determined by hand of user facing shade from inside, unless otherwise indicated in a window treatment schedule.

G. Remote Controls: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following devices for remote-control activation of shades:

1. Control Stations: Momentary-contact, three-position, switch-operated control station with open, close, and off functions.

H. Limit Switches: Adjustable switches, interlocked with motor controls and set to automatically stop shade at fully raised and fully lowered positions.

I. Operating Function: Stop and hold shade at any position.

J. See Window Treatment Schedule Treatment, Section 12494A at end of document.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (50 mm) to interior face of glass. Allow clearances for window operation hardware.

B. Connections: Connect motorized operators to building electrical system.

3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain roller shades. Refer to Division 1 Section Demonstration and Training."

END OF SECTION 122413

Room #	Room Name	Shade Type	Window Type	# of Window Units	# of Shade Units per Opening	Clutch Control Location	Shade Size
107A	Solar	RS1	W-1	2	1	Right	
		RS1	W-2	1	2	Right	1@3'-0"x3'-0" 1@6'-0"x3'-0"
		RS2	W-3	1	3	Right	3@6'-0"x3'-0"
107B	Solar Thermal	RS1	W-1	2	1	Right	
		RS1	W-2	1	2	Right	1@3'-0"x3'-0" 1@6'-0"x3'-0"
		RS2	W-3	1	3	Right	3@6'-0"x3'-0"
109	Energy/Seminar Classroom	RS1	W-1	1	1	Right	
		RS1	W-2	1	2	Right	1@3'-0"x3'-0" 1@6'-0"x3'-0"
		RS2	W-4	1	2	Right	2@6'-0"x3'-0"
107	Biofuel Technology	RS1	W-1	1	1	Right	
		RS1	W-2	1	2	Right	1@3'-0"x3'-0" 1@6'-0"x3'-0"
		RS2	W-4	1	2	Right	2@6'-0"x3'-0"

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SECTION 123200 – MODULAR CASEWORK

PART 1 – PRODUCTS

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 1 Sections, including “Sustainable Design Requirements”, “Construction Waste Managements” and “Commissioning Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Fixed modular laminate clad casework, filler panels, and components.
2. Plastic laminate Countertops.
3. Accessories.
4. Shelves.

B. Related Sections include the following:

1. Division 6 Section “Miscellaneous Carpentry" for wood blocking for anchoring casework.
2. Division 6 Section “Interior Architectural Woodwork" for custom casework and millwork.
3. Division 9 Section "Resilient Wall Base and Accessories" for resilient base applied to plastic-laminate casework.
4. Division 22 Sections for plumbing and fixtures in casework.
5. Division 26 Sections for Electrical work in casework.

1.3 DEFINITIONS

A. Identification of casework components and related products by surface visibility.

1. Open Interiors: Any open storage unit without solid door or drawer fronts and units with full glass insert doors and/or acrylic doors.

2. Closed Interiors: Any closed storage unit behind solid door or drawer fronts, sliding solid doors.

3. Exposed Ends: Any storage unit exterior side surface that is visible after installation.

4. Other Exposed Surfaces: Faces of doors and drawers when closed, and tops of cabinets less than 78 inches above furnished floor.

5. Semi-Exposed Surfaces: Interior surfaces which are visible, bottoms of wall cabinets and tops of cabinets 78 inches or more above finished floor.

6. Concealed Surfaces: Any surface not visible after installation.

1.4 QUALITY ASSURANCE

A. Manufacturer: Minimum of 10 years experience in providing manufactured casework systems for similar types of projects, produce evidence of financial stability, bonding capacity, and adequate facilities and personnel required to perform on this project.

B. Source Limitations: Obtain each type casework from single source from single manufacturer unless otherwise indicated. Obtain each type of countertops, sinks, accessories and service fittings from casework manufacturer.
   a. Fixed modular laminate clad casework, filler panels, and components.
   b. Music storage systems

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. As a prerequisite for consideration as a substitute, any manufacturer requesting approval must provide documentation that they are an AWI Quality Certified (AWI-QCP) Premium Grade manufacturer, as well as Independent Test Results indicating performance characteristics meeting or exceeding the standards as set by ANSI A161.1, SEFA-8 and AWI.

E. Casework must comply with the design, quality of materials, workmanship, and performance of the casework components specified herein and as shown on the plans, regardless of the manufacturer's "product standards".

F. Manufacturer's requesting approval shall provide a detailed listing of compliance and deviations from these documents, catalogs, specifications, and full-size cabinet samples, conforming to the specifications, at the architect's request. Refer to Section 1600.

G. Any request for substitution not containing these items will be denied consideration.

1.5 SUBMITTALS

A. Product Data: Manufacturer's catalog with specifications and construction details.

   1. Indicate systems and components to be utilized.
   2. Provide product data for all accessories and other components.
   3. Provide product data for all mechanical, electrical and plumbing components.

B. Product Data: For panel products, high-pressure decorative laminate, solid-surfacing material, including cabinet hardware and accessories, and finishing materials and processes.

   1. Include data and certifications for fire-retardant treatment and finishes that indicate finish materials comply with requirements.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

D. Shop Drawings**:** Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Include section drawings of typical and special casework, work surfaces and accessories.
2. Show details full size.
3. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other laboratory equipment.
4. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
5. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, and other items installed in architectural woodwork.
6. Indicate locations of plumbing and electrical service field connection by others.
7. Include details of utility spaces showing supports for conduits and piping.
8. Include details of exposed conduits, if required, for service fittings.

E. Samples for Initial Selection. Upon request provide following:

1. Shop-applied transparent finishes.
2. Shop-applied opaque finishes.
3. Plastic laminates.
4. PVC edge material.
5. Thermoset decorative panels.
6. Solid-surfacing materials.

F. Samples for Verification:

1. Submit minimum of (4) sets of each wood product. Provide samples which indicate the full range of anticipated color, grain, and figuring .

    a. Lumber with or for transparent finish, not less than 4 inches wide by 12 inches for each species and cut, finished on 1 side and 1 edge.
    b. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
    c. Veneer-faced panel products with or for transparent finish, 8 by 10 inches for each species and cut. Include at least one face-veneer seam and finish as specified.
    d. Thermoset decorative-panels, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with edge banding on 1 edge.
    e. Solid-surfacing materials, 6 inches square.

2. Submit 1 each of the following

a. Each laminate and matching edge banding selections for verification.

3. Submit the following upon request only

a. Base cabinet and wall Cabinet conforming to specifications, with drawer and door. Cabinet samples shall be complete with specified hardware
b. Sample drawer construction
c. Miter joints for standing trim.
d. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, 18 inches (450 mm) high by 18 inches (450 mm) wide by 6 inches (150 mm) deep.
e. Exposed cabinet hardware, drawer guides and other accessories.
f. Thermoset decorative-panels, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with edge banding on 1 edge.

G. Qualification Data upon request for Installer and fabricator.

H. Woodwork Quality Standard Compliance Certificates:

I. Refer to additional submittal requirements as described in Division 1 Section “Sustainable Design Requirements”

J. Refer to additional submittal requirements as described in Division 1 Section “Sustainable Design Requirements”

1.6 DELIVERY, STORAGE, & PRODUCT HANDLING

A. Completed laminate clad casework, countertops, and related products are to be delivered to project site only after wet operations in building are completed, store in ventilated place, protected from the weather, with relative humidity range of 25 percent to 55 percent.

B. Protect finished surfaces from soiling and damage during handling and installation with a protective covering.

1.7 COORDINATION

K. Coordinate delivery, layout, rough-in and installation for support of modular casework.

L. Coordinate installation of modular casework with installation of plumbing, electrical, and mechanical equipment.

M. The casework contractor shall verify all critical building dimensions prior to fabrication of casework. The casework manufacturer shall re-configure the casework arrangement to dimensions requiring 2-1/2” of less of filler at each end of wall-to-wall elevations and to ensure a complete and satisfactory installation.

1.8 JOB CONDITIONS

A. Environmental Requirements: Do not install casework until permanent HVAC systems are operating and temperature and humidity have been stabilized for at least 1 week.

1. Manufacturer/Supplier shall advise Contractor of temperature and humidity requirements for architectural casework installation areas.
2. After installation, control temperature and humidity to maintain relative humidity between 25 percent and 55 percent.

B. Conditions: Do not install casework until interior concrete work, masonry, plastering and other wet operations are complete.

1.9 WARRANTY

A. All materials and workmanship covered by this section will carry a five (5) year warranty from date of acceptance & a ten (10) year warranty for instrument storage units, unless otherwise noted.

PART 2 – PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS:

A. Basis-of-Design Product: Subject to compliance with requirements, provide listed manufacturer or a comparable product by one of the manufacturers listed below. The use of a trade name and/or suppliers name and address in the specifications is to indicate a possible source of the product and a standard of quality. Products of the same type from other sources shall not be excluded, provided they possess like physical and functional and aesthetic characteristics.

B. Basis-of-Design:

1. Fixed modular laminate clad casework, at typical classrooms except science classroom and where noted otherwise: Case Systems, Inc.

C. Acceptable Manufacturers:

1. Fixed modular laminate clad casework:

a. LSI Corporation
b. Case Systems, Inc.
c. Polyvision, A division of Steelcase
d. TMI Systems Design
e. Stevens Industries, Inc.

2. Other manufacturer requesting substitution shall comply with paragraph 1.04

2.2 MATERIALS

A. Core Materials:

1. Particleboard up to 7/8 inch thick: Industrial Grade average 47-pound density particleboard, ANSI A 208.1-1999, M-3.
2. Particleboard 1 inch thick and thicker: Industrial Grade average 45-pound density particle-board, ANSI A 208.1-1999, M-2.
3. Medium Density Fiberboard 1/4 inch thick: Average 54-pound density grade, ANSI A208.2.

4. Hardwood Plywood: HPVA HP-1, either veneer core or particleboard core, unless otherwise indicated
5. Moisture resistant particleboard up to 1 inch thick: Industrial Grade average 45-pound density particleboard, ANSI A 208.1-1999, M-3.
6. All hardboard shall be tempered with a S2S surface finish and must meet or exceed the hardboard product standard ANSI-A135.5.
7. Exterior grade resins.
8. Casework and work surface core panel materials to be made of engineered board that:

    a. Meets ANSI 208.1 M2 PB specifications
    b. Made from 100% certified recycled or recovered wood fiber
    c. Uses formaldehyde-free, exterior-grade polyurethane resin (NAF)
    d. Provide Forest Stewardship Council (FSC) chain-of-custody and Environmentally Preferable Product (EPP) certified (must provide copies of certifications)
    e. Has VOC emission factors that are less than 0.01 ppm
        1. Roseburg Hybrid Green Panel Sky Blend
        2. Uniboard, Nu-green
        3. Approved Equivalent

B. Decorative Laminates:

1. High-pressure decorative laminate HGP, Type 390, Wilsonart, Chemsurf Chemical Resistant Laminate, or approved equivalent.
2. High-pressure cabinet liner CLS (.020), NEMA Test LD 3-2000.
3. High-pressure backer BKH (.048), (.039), (.028), NEMA Test LD3-2000.
4. Thermally fused melamine laminate, NEMA Test LD 3-2000, Color as selected by Architect.

C. Laminate Color Selection: See Finish Schedule

D. Edging Materials:

1. 1mm PVC banding at body front edge, interior components and leading edge of shelves.
2. 3mm PVC banding, machine profiled to 1/8 inch radius at door and drawer fronts, countertops, backsplashes and all edges of miscellaneous wall shelving
3. Banding Color Selection: As selected from manufacturer's full range, including solid, pattern and wood grains matching laminate colors. Architect will select a color to coordinate with final selection of each component laminate.

2.3 CABINET HARDWARE

A. Hinges:

1. Five knuckle, stainless steel, institutional grade, 2-3/4 inch overlay type with hospital tip. 0.095 inch thick. ANSI-BHMA standard A156.9, Grade 1.

    a. Doors 48 inches and over in height have 3 hinges per door.
    b. Doors greater than 80 inches in height to have 4 hinges

c. Magnetic door catch with maximum 5 pound pull provided, attached with screws and slotted for adjustment.

B. Pulls:

1. Door and drawer front pulls, are stainless steel wire type, 96mm spacing on screws. Pull design shall comply with the Americans with Disability Act (ADA). Install with "tamperproof" screws.

2. Orientation of pulls to be as indicated on drawings.

C. Drawer Slides:

1. Regular knee space and pencil: 100-pound load rated epoxy coated steel, bottom corner mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature. Paper storage, full extension 150-pound load rated epoxy coated steel slides.
2. File: Full extension, 150-pound load rated epoxy coated steel, bottom corner mounted with smooth and quiet nylon rollers. Positive stop both directions with self-closing feature.

D. Adjustable Shelf Supports:

1. Injection molded transparent polycarbonate friction fit into cabinet end panels and vertical dividers, adjustable on 32mm centers. Each shelf support has 2 integral support pins, 5mm diameter, to interface pre-drilled holes, and to prevent accidental rotation of support. The support automatically adapts to 3/4 inch or 1 inch thick shelving and provides non-tip feature for shelving. Supports may be field fixed if desired. Structural load to 1200 pounds (300 pounds per support) without failure.

E. Locks:

1. **All drawers and doors shall be lockable unless noted otherwise.**
2. Removable core, disc tumbler, cam style lock with strike. Lock for sliding 3/4 inch thick doors is a disc type plunger lock, sliding door type with strike. Lock for sliding glass/acrylic doors is a ratchet type sliding showcase lock. Dull chrome finish.
3. Elbow catch or chain bolt used to secure inactive door on all locked cabinets.

F. Sliding Door Track: Anodized aluminum double channel.

G. File Suspension System: Extruded molding integral with top of drawer box sides to accept standard hanging file folders.

H. Locking as indicated on drawings shall be keyed alike by room and master keyed.

I. Support Members: Countertop support brackets: Epoxy powder coated, 11 gauge steel with integral cleat mount opening and wire management opening.

J. Grommets for Cable Passage through Countertops: Manufacturer's standard molded-plastic grommets and matching plastic caps with slot for wire passage. Diameter: **2 3/8 inch**, color to be selected.

K. Double Waste Bin Organizer
1. Double Waste Bin, floor mounted, manual full extension, frame clearance 9 ¾". Capacity: 2x15 liters (4gal)

a. Colors: White and Green
b. Model Number: Hafele 502.70.767

2. Follower, for hinged door pullout

a. Material: steel
b. Color: White
c. Model Number: Hafele 502.43.797

2.4 FABRICATION:

A. **Conform to AWI Section 1600 unless otherwise indicated. All exposed wood veneer shall comply with AWI Sections 400 for matching of veneer, direction and matching of grain.**

B. Fabricate casework, countertops and related products to dimensions, profiles, and details shown.

C. All casework panel components to be finished precisely to size and squareness within 0.01 inches utilizing a sizing process to ensure strict dimensional quality and structural integrity in the final fabricated product.

D. Cabinet Body Construction:
1. Tops and bottoms are glued and doweled to cabinet sides and internal cabinet components such as fixed horizontals, rails and verticals. Minimum 6 dowels each joint for 24 inch deep cabinets and a minimum of 4 dowels each joint for 12 inch deep cabinets.

a. Tops, bottoms and sides of all cabinets are 3/4 inch particleboard core.

2. Cabinet backs: 1/2 inch thick particleboard core.

a. Exposed back on fixed or movable cabinets: 3/4 inch thick particleboard with the exterior surface finished in VGS laminate as selected.
3. Fixed base and tall units have an individual factory-applied base, constructed of 3/4 inch thick exterior grade plywood. Base is nominal 4 inch high unless otherwise indicated on the drawings.
4. Base units, except sink base units: Full sub-top. Sink base units are provided with open top and a stretcher at the front, attached to the sides. Back to be split removable access panel.
5. Side panels and vertical dividers shall receive adjustable shelf hardware at 32mm line boring centers. Mount door hinges, drawer slides and pull-out shelves in the line boring for consistent alignment.
6. Exposed and semi exposed edges: High Pressure Decorative Laminate.
7. Adjustable shelf: 3/4 inch thick particleboard up to 36 inches wide, 1 inch thick particleboard over 36 inches wide. Shelves in open cabinets, regardless of width, shall be 1 inch thick particleboard. Edging: 1mm PVC banding all 4 edges.
8. Interior finish, units with open Interiors:

a. Top, bottom, sides, horizontal and vertical members, and adjustable shelving faces with thermally fused high-pressure decorative laminate with matching prefinished back.

9. Interior finish, units with closed Interiors:

a. Top, bottom, sides, horizontal and vertical members, and adjustable shelving faces with thermally fused melamine laminate with matching prefinished back.

10. Exposed ends:

a. Faced with VGS high-pressure decorative laminate.

11. Wall unit bottom:

a. Faced with thermally fused melamine laminate.

12. Balanced construction of all laminated panels is mandatory. Unfinished core stock surfaces, even on concealed surfaces (excluding edges), are not permitted.

D. Drawers:

1. Sides, back and sub front: Minimum 1/2 inch thick particleboard, laminated with thermally fused melamine doweled and glued into sides. Top edge banded with 1mm PVC.
2. Drawer bottom: Minimum 1/2 inch thick particleboard laminated with thermally fused melamine, screwed directly to the bottom edges of drawer box.
3. Paper storage drawers: Minimum 3/4 inch thick particleboard sides, back, and sub front laminated with thermally fused melamine. Minimum 1/2 inch thick particleboard drawer bottoms screwed directly to the bottom edges of the drawer box. Provide PVC angle retaining bar at the rear of the drawer.

E. Door/Drawer Fronts:

1. Core: 3/4 inch thick particleboard. Door and drawer fronts shall be overlay door design.
2. Provide double doors in opening in excess of 24 inches wide.
3. Faces:
   a. Exterior: VGS High-pressure decorative laminate.
   b. Interior: High-pressure cabinet liner CLS.
4. Door/drawer edges: High-pressure decorative laminate and outside corners machine profiled to 1/8 inch radius.

F. Shelving:

1. Core material: 3/4 inch or 1 inch thick particleboard.
2. Exterior: Thermally fused melamine laminate,.
3. Edges: 1mm PVC banding, **all 4 edges.**

2.5 DECORATIVE LAMINATE COUNTERTOPS

A. Core: 1 inch thick ANSI A208.1-1993 M-2 particleboard except at counters containing sinks, at which the core material shall be moisture resistant particleboard.

B. Surface: HGS/HGP high-pressure decorative laminate with balanced backer sheeting.

C. Edges, including applied backsplash: 3mm PVC, exposed edges and corners machine profiled to 1/8 inch radius. Edges are machine applied with water based low Volatile Organic Compound (VOC), non-toxic, PVA adhesive.

D. No joints shall be closer than 24 inches to either side of the sink cutouts.

E. Unless otherwise indicated on drawings, all countertops shall be provided with 4" high back and sides splashes where counters abut wall surfaces.

PART 3- EXECUTION

3.1 INSPECTION:

A. Installer shall examine the substrates and supporting structure and the conditions under which the casework work is to be installed, including compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of laboratory casework.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION:

A. Condition casework to average prevailing humidity conditions in installation areas prior to start of installation.

3.3 INSTALLATION:

A. Install level, plumb, and true; shim as required, using concealed shims. Where laminate clad casework abuts other finished work, including but not limited to pipes, ducts, and column enclosures, scribe and cut to accurate fit. Install to tolerance of 1/8 inch in 96 inches for plumb and level. Install adjoining trim with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.

B. Securely attach carpentry work to substrate and supporting members using fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials. Install fasteners without splitting wood; fasten panel products to allow for expansion at joints unless otherwise indicated.

C. Fit carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction. Install wood trim with minimum number of joints practical, using full-length pieces from maximum lengths of lumber available. Cope at returns and miter at corners to produce tight-fitting joints with full-surface contact throughout length of joint. Use scarf joints for end-to-end joints. Install trim after gypsum board joint finishing operations are completed.

D. Countersink nail heads on exposed carpentry work and fill holes with wood filler.

3.4 INSTALLATION OF CABINETS

A. Base Cabinets: Adjust top rails and subtops within 1/16 inch of a single plane. Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions with fasteners spaced not more than 24 inches o.c. Fasten adjacent cabinets together with joints flush, tight, and uniform. Align similar adjoining doors and drawers to a tolerance of 1/16 inch.

1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches (600 mm) o.c. and at sides of cabinets with not less than 2 fasteners per side.

B. Wall Cabinets: Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 24 inches o.c. Align similar adjoining doors to a tolerance of 1/16 inch.

C. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

D. Adjust casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.5 INSTALLATION OF COUNTERTOPS

A. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where shown on Shop Drawings.

B. 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.

1. Use concealed clamping devices for field joints in plastic-laminate countertops. Locate clamping devices within 6 inches of front and back edges and at intervals not exceeding 24 inches. Tighten according to manufacturer's written instructions to exert a uniform heavy pressure at joints.

C. Fastening:

1. Secure countertops, except for epoxy countertops, to cabinets with Z-type fasteners or equivalent, using two or more fasteners at each cabinet front, end, and back.

2. Where necessary to penetrate countertops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal to countertop in chemical resistance, hardness, and appearance.

D. Provide required holes and cutouts for fixtures and fittings.

E. Seal unfinished edges and cutouts in plastic-laminate countertops with a heavy coat of polyurethane varnish.

F. Provide scribe moldings for closures at junctures of countertop, curb, and splash, with walls as recommended by manufacturer for materials involved. Match materials and finish to adjacent laboratory casework. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.

G. Carefully dress joints smooth, remove surface scratches, and clean entire surface.

3.6 INSTALLATION OF SINKS

A. Semiflush Installation of Stainless-Steel Sinks: Before setting, apply sink and countertop manufacturers' recommended sealant under rim lip and along top. Remove excess sealant while still wet and finish joint for neat appearance.

3.7 CLEANING AND ADJUSTMENT:

A. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind.

B. Repair minor damage per plastic laminate manufacturer’s recommendations.

C. Remove and dispose of all packing materials and related construction debris.

D. Clean cabinets inside and out. Wipe off fingerprints, pencil marks, and surface soil etc., in preparation for final cleaning by the building owner.

END OF SECTION 123200

DIVISION 21 SECTION 210500
COMMON WORK RESULTS FOR FIRE PROTECTION
TABLE OF CONTENTS

SECTION 210500 - COMMON WORK RESULTS FOR FIRE PROTECTION

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 1 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2. SUMMARY

A. All work under Division 21 is subject to the Division 01, *General Conditions* and Special Requirements for the entire contract.

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, and piping up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 21 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.3. PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File

necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the Division 01, *General Requirements* of the specification.

1.4. EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.5. CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 21 shall be fully qualified and acceptable to the Architect and Owner. Submit the following evidence when requested:

1. A list of not less than five comparable projects which the Contractor completed.
2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
3. Local and/or State License, where required.
4. Membership in trade or professional organizations where required.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.6. MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to

determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.7. FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.8. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

B. ASTM - American Society for Testing and Materials

C. FM - Factory Mutual

D. IBC - International Building Code

E. IEEE - Institute of Electrical and Electronics Engineers

F. MSSP - Manufacturers Standards Society of the Valve and Fittings Industry

G. NEC - National Electrical Code

H. NEMA - National Electrical Manufacturers Association

I. NFPA - National Fire Protection Association

J. UL - Underwriters' Laboratories

K. All equipment materials, piping and installation shall comply with the codes and

standards listed in the enforceable edition of the Applicable National Fire Protection Association Pamphlets.

1.9. SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6) copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

I. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.10. SHOP DRAWINGS

A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. Items and Systems

Access Doors/Panels including layout and location
Backflow Preventers
Coordinated Drawings
Drip Pans
Exterior Equipment/Piping Supports
Fire Protection System including Hydraulic Calculations, Equipment and Devices
Fire Stopping - Methods and Materials
Identification System
Material and Equipment List
Operations and Maintenance Manuals
Pipe Materials Including Itemized Schedule
Preliminary Pipe Pressure Tests
Pressure Relief Valves
Pressure Gauges
Test Certificates
Valves
Vibration Isolation Materials
Wiring Diagrams, Flow Diagrams and Operating Instructions
Zone Valve Assemblies and Wire Mesh Enclosures

E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked *Reviewed* or *Comments Noted*. After the proposed materials have been reviewed, no substitution will be permitted except where approved by the Architect.

F. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.11. SUPERVISION AND COORDINATION

A. Provide complete supervision, direction, scheduling, and coordination of all work under the Contract, including that of subcontractors.

B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, equipment, and other work performed under Division 21.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for fire protection installations.

D. Coordinate electrical work required under Division 21 with that under Division 26. Coordinate all work under Division 21 with work under all other Divisions.

E. Supply services of an experienced (10 years minimum) and competent Project Manager to be in constant charge of work at site.

F. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.

G. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the intent of the contract documents.

H. Coordinate installation of large equipment requiring positioning before closing in building.

1.12. CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 21. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike

manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Structural Engineer.

1.13. PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where pipes penetrate roofs, flash pipe with Stoneman *Stormtite*, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install curbs, specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer’s instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.14. CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 21. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.15. CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the drawings, where existing fire protection work is removed, pipes, valves, etc., shall be removed, including hangers, to a point below finished floors or behind finished walls and capped. Such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 21 connects to existing equipment and piping, etc.,

Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 21, or under other Divisions, requires relocation of existing equipment, piping, etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

1.16. EXCAVATION AND BACKFILLING

A. General

1. Perform all necessary excavation, or installation of work under Division 21, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.17. DRIVE GUARDS

A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than

one direction.

B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.18. VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, or piping to building structure. See Division 23 Section, *Vibration Control for HVAC Plumbing and Fire Protection Equipment.*

1.19. ALTERNATES

A. Refer to Division 01, *-Alternates* for description of work under this section affected by alternates.

1.20. DEFINITIONS

A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.

E. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space.

F. *Exposed* means not installed underground or *concealed* as defined above.

G. *Invert Elevation* means the elevation of the inside bottom of pipe.

H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

I. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does

not constitute a waiver or alteration of the contract requirements.

J. *Building Line:* Exterior wall of building.

1.21. MINIMUM EFFICIENCY REQUIREMENTS

A. All fire protection equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

B. All fire protection equipment shall comply with ASHRAE Standard 90.1, latest edition.

1.22. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED Requirements.

PART 2. ELECTRICAL REQUIREMENTS

2.1. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 21 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 21. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 21.

B. All electrical work performed under Division 21 shall conform to the applicable requirements of Division 26 and conforming to the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA and the IBC.

C. Provide wiring diagrams with electrical characteristics and connection requirements.

D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.

G. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

H. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.

I. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.2. MOTORS AND CONTROLS

A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG l.

C. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.
2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR^2 of the driven equipment to operating speed.
3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.
4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.
5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

D. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-

proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components. When approved by the Engineer, deviations from the specifications will be permitted as follows:

1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.
2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.

E. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.

F. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1HP and above to	85.5 percent	84 percent
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent
5HP	89.5 percent	87 percent
7½ HP	91 percent	86 percent
10HP	91.7 percent	85 percent
15HP	93.0 percent	85 percent
20HP	93.0 percent	86 percent
25HP	93.6 percent	85 percent
50HP and above	94.5 percent	88 percent

60 HP	95.0 percent	90 percent
75HP	95.0 percent	90 percent
100 HP	95.4 percent	90 percent
125 HP	95.8 percent	95 percent
150 HP and above	96.0 percent	95 percent

G. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

H. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.

2.3. MOTOR INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.

C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.

2.4. WIRING DIAGRAMS

A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.

B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.

PART 3. EXECUTION

3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install fire protection equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.2. SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of galvanized steel utilizing galvanized rods, nuts, washers, bolts, etc. At contractor's option stainless steel may be utilized for exterior hangers, rods, nuts, washers, bolts, etc.

C. Concrete housekeeping pads and foundations shall be not less than 4 inches high and shall extend a minimum of 6 inches beyond equipment bases. Provide wire-mesh reinforcement; chamfer exposed edges and corners; and finish exposed surfaces smooth.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while

video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4. PROVISIONS FOR ACCESS

A. The contractor shall provide access panels and doors for all concealed equipment, valves, strainers, controls, control devices, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.5. PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 21 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and conform to ANSI Standards.

H. All exposed piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.6. CLEANING OF SYSTEMS

A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting equipment, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.

B. Flush piping to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of service company used.

C. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

D. Leave systems clean, and in complete running order.

3.7. COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.8. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.9. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

A. Contractor shall submit for approval working fire protection drawings of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged.

C. All items of equipment, including motor starters, fire pump controllers, jockey pump controllers and disconnects shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal).

D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Operation and Maintenance Booklet* as hereinafter specified.

E. All lines piping installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and service. Refer to Division 21 Section, *Fire Protection Piping, Fittings, Valves, Etc*. Color code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for fire protection identification. Submit samples of equipment identification cards, piping labels, and valve tags to Engineer for review prior to installation.

G. Provide at least 8 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner.

H. Contractor shall demonstrate Sequences of Operation of all fire protection equipment in presence of Owner's representative, and Fire Marshal.

3.11. WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by piping or conduit under Division 21 shall be sleeved, sealed, and caulked airtight for sound and air transfer control.

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, *Fire Protection, HVAC and Plumbing Protection Firestopping.*

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide pipe escutcheons for sleeved pipes in finished areas.

E. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.12. RECORD DRAWINGS

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect one complete set of prints of the fire protection drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the GENERAL CONDITIONS.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.

C. The contractor guarantees for a two year period from the time of final acceptance by the Owner.

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the *Operations and Maintenance Booklet.*

B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATION AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six(6) copies of the Operation and Maintenance Manuals and deliver these copies of the manuals to the Owner. The manuals shall be as specified herein. The manuals must be approved and will not be accepted as final until so stamped.

B. The manuals shall be bound in a three-ring loose-leaf binder similar to National No. 3881

with the following title lettered on the front: *Operations and Maintenance Manuals – Delaware Technical & Community College Sustainable Energy Training Center – Fire Protection.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Manufacturer's extended limited warranties on equipment.
4. Chart form indicating frequency and type of routine maintenance for all fire protection equipment. The chart shall also indicate model number of equipment, location and service.
5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
6. Provide supplier and subcontractor's names, address, and phone number.
7. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
8. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass.
9. Access panel charts with index illustrating the location and purpose of access panels.
10. Approved Fire Protection Certificates.
11. Start-up reports for equipment.

D. Submit *Operations and Maintenance Manuals* prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that *Operations and Maintenance Manuals* be reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:

1. Complete Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, and piping in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other

architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

3.17. PIPING SYSTEMS TESTING

A. The entire new fire protection piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	**TEST PRESSURE**
Fire Protection (Refer to NFPA)	200 psi

B. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

END OF SECTION

DIVISION 21 SECTION 210505
FIRE PROTECTION PIPING, FITTINGS AND VALVES
TABLE OF CONTENTS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. SUMMARY

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

1.3. SYSTEM DESCRIPTION CONDITIONS

A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings.

B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and the authority having jurisdiction.

C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

F. Provide pipe hangers and supports in accordance with ASTM B31.9, MSS SP69 and NFPA-13 unless indicated otherwise.

G. Use 3/4 inch (20 mm) ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

1.4. QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

C. If the product is available domestically it shall be supplied as such.

1.5. DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under as hereinbefore specified.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

1.6. ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.7. EXTRA MATERIALS

A. Provide one (1) repacking kit for each size valve.

1.8. ALTERNATES

A. Refer to Division 01 - *Alternates* for description of work under this section affected by alternates.

1.9. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED Requirements.

PART 2. PRODUCTS

2.1. PIPE MATERIALS

A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.

1. Fire Protection Piping (NFPA-13):

a). Piping Underground: Steel, schedule 40, ASTM A53, black pipe with ASME C105 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape, or listed ductile iron pipe.

b). Piping Above Grade: Steel, schedule 40, ASTM A53, black pipe. Piping 4 inches and smaller shall be ASTM A120, black steel pipe. Sizes 4-inches and above shall be standard weight, black, cast iron with screwed fittings, schedule 10 steel piping shall be acceptable when approved by the authority having jurisdiction.

c). Wet Pipe Fittings: Steel fittings shall be ASME B16.9, wrought steel, butt welded. Cast iron fittings shall be ASME 16.1, flanges and flanged fittings. Malleable iron fittings shall be ASME B16.3, threaded fittings. Mechanical grooved couplings shall be malleable iron housing clamps to engage and lock *C* shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe. Mechanical formed fittings shall be carbon steel housing with integral pipe stop and O-ring and O-ring uniformity compressed into permanent mechanical engagement onto pipe.

d). Dry Pipe Fittings: UL listed for dry pipe service.

e). Victaulic grooved end fittings and mechanical couplings shall be used for wet pipe and dry pipe systems 2” and larger. Couplings and fittings shall be UL listed and FM approved. Fittings shall be ASTM A536 ductile iron, ASTM A234 forged steel or ASTM A53 fabricated steel with factory grooved ends designed to accept Victaulic couplings.

f). Victaulic mechanical couplings shall consist of two ASTM A536 ductile iron housings, pressure-responsive, synthetic rubber gasket and plated steel bolts and nuts.

i. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA-13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer’s latest recommendation.

1.) 1-1/4” through 8”: “Installation Ready” stab-on

rigid coupling, designed for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic FireLock EZ Style 009H (1-1/4" – 4") and Victaulic QuickVic Style 107H (2"-8").

2.) 2" and Larger: Standard rigid coupling design. Victaulic Style 07 Zero-Flex.

ii. Flexible Type: Use in seismic areas and where required by NFPA-13.

1.) 2" through 8": "Installation Ready" stab-on flexible coupling, designed for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts. Victaulic QuickVic Style 177.

2.) 2" and Larger: Standard flexible coupling design. Victaulic Style 75 or 77.

3.)

Fire Protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	Grade EPDM, Type A – FlushSeal, FireLock EZ, or QuickVic Design
Freezer Applications	-30°F to 0°F (-34°C to 17°C)	Grade L Silicone FlushSeal® Design
Water/Wet Systems	Ambient	Grade EPDM, Type A – C-Shaped, FireLock EZ, or QuickVic Design

g). Gate Valves: 2-1/2 inches & larger - listed 175 lb. OS&Y, flanged. 2 inches & smaller - UL/FM listed 175 lb., bronze, screwed. Furnish all sprinkler control valves with slow close manual operator and position indicator. Tamper switches furnish under Division 15 Section, *Fire Protection*.

h). Grooved End Gate Valves: 2-1/2 inches and Larger – UL listed/FM approved, 250 psi maximum pressure rating, OS&Y ductile iron body, bronze mounted, grooved ends. Victaulic FireLock Series 771.

i). Grooved End Butterfly Valves: 2 inches & Larger: UL listed/FM approved, up to 365 psi maximum pressure rating, ductile iron body, nickel-plated ductile iron disc, Nitrile seat, weather-proof actuator with two pre-wired supervisory switches. Victaulic FireLock Series 765 or Series 705.

j). Globe Valves: 2 inches & smaller - 175 lb., bronze, screwed, UL/FM listed.

k). Check Valves: 2-1/2 inches & smaller - UL/FM listed 175 lb., flanged swing check. 2 inches & smaller - listed 175 lb., bronze swing check, screwed.

l). Grooved End Check Valves: 2 inches or Larger: UL listed/FM approved, up to 365 psi maximum pressure rating, ductile iron body, spring-loaded

stainless steel or EPDM coated ductile iron disc, nickel-plated or welded-in nickel seat. Victaulic FireLock Series 717H or Series 717.

m). Finish: All exposed fire protection piping shall be primed and painted with epoxy red paint. White letters shall indicate pipe and indicate direction of flow. Painting shall be provided under Division 09.

n). Special Requirements: All fire protection piping, valves, fittings and joints shall comply with applicable National Fire Protection Pamphlets (NFPA) local codes, building codes, Fire Marshal, Owner's Insurance Underwriter, and the authority having jurisdiction.

B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, Allied Tube, or Wheatland, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.

C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.

D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. PIPE HANGERS

A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260 for pipe ¾-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
3/4 & 1	6	5	3/8
1 - ½	6	8	3/8
2	8	8	3/8
2 – ½	10	9	½
3	12	10	½

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
4	14	12	5/8
5	14	12	5/8
6	16	14	3/4

B. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.

C. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring, comply with NFPA-13.

D. Hangers for pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis. Comply with NFPA-13.

E. Hangers for cold pipe sizes 6 inches (150 mm) and over: adjustable steel yoke, cast iron roll, double hanger, comply with NFPA-13.

F. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.

G. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook, comply with NFPA-13.

H. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp, comply with NFPA-13.

I. Wall support for pipe sizes 6 inches (150 mm) and over: welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll, comply with NFPA-13..

J. Vertical Support: Steel riser clamp, comply with NFPA-13.

K. Floor support for pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support, comply with NFPA-13.

L. Copper pipe support: Carbon steel ring, adjustable, copper plated, comply with NFPA-13.

M. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded, comply with NFPA-13.

N. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

O. Victaulic Style 009H, 107H, and 07 rigid couplings may be used with IPS steel piping systems, which meet the support and hanging requirements of NFPA 13. An adequate number of Victaulic Style 177, 75, and 77 flexible couplings shall also be used to compensate for thermal expansion/contraction of the pipe.

2.3. VALVES

A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer. All valves shall be provided with tamper switches and coordinated with Division 28.

2.4. PRESSURE GAUGES

A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Trerice Model 600C; Weksler Instruments, Ernst Gage Co., Miljoco, or as approved equal.

B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.

C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.

D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.

E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Trerice, RS1/RS6 by Wexler Instruments, Miljoco, or as approved equal.

2.5. ESCUTCHEONS

A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.

B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.6. DIELECTRIC CONNECTIONS:

A. Furnish and install electrically insulated dielectric waterway fittings, unions or flanges, as manufactured by EPCO Sales, Inc., or Victaulic Co.at the following locations:

1. Where steel piping systems join copper piping.
2. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.

2.7. SLEEVES

A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.

B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend ¾-inch above the floor. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.

C. Sleeves through walls and floors shall be sealed with graphite packing and molten lead and sealed with a waterproof caulking compound.

D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.8. WATER PROOF PIPE PENETRATION SEALS

A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.

B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from –40 degrees F to 250 degrees F.

PART 3. EXECUTION

3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, and installed so that there will be no interference with the installation of the equipment. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.

B. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.

C. All valves and other fittings shall be readily accessible.

D. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.

E. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.

F. Install all valves with stem upright or horizontal, not inverted.

G. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.

H. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

I. All water containing pipes shall be routed clear of combustion air dampers and louvers to prevent freezing condition when dampers are open.

3.2. PRESSURE GAGE INSTALLATION REQUIREMENTS.

A. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.

B. Adjust faces of thermometer and gages to proper angle for best visibility.

C. Clean windows of gages and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.3. VALVE INSTALLATION REQUIREMENTS

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

G. Install valves as indicated, according to manufacturer's written instructions.

H. Piping installation requirements are specified in other Division 21 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

I. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

J. Locate valves for easy access and provide separate support where necessary.

K. Install valves in horizontal piping with stem at or above the center of the pipe.

L. Install valves in a position to allow full stem movement.

M. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

3.4. PIPE JOINTS INSTALLATION REQUIREMENTS

A. Screwed Joints: All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.

B. Grooved Joints: Install in accordance with the manufacturer’s (Victaulic) guidelines and

recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

C. Soldered Joints and Copper Piping: Joints in copper piping shall conform to the following minimum standards.

1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
5. Solder joints shall be made by using a direct flame from a torch.
6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.

D. Where copper piping joins steel piping, approved bronze adapters shall be used.

E. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

3.5. HANGERS AND SUPPORTS INSTALLATION REQUIREMENTS

A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal. Comply with NFPA-13.

B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping.

C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.

D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.

E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.

F. Select hangers and components for loads imposed. Secure rods with double nuts.

G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.

H. Support overhead piping with clevis hangers.

I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.

J. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

K. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

L. Refer to structural documents for appropriate connection/attachment materials to building.

3.6. PIPING IDENTIFICATION INSTALLATION

A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.

B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule

shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.7. VALVE IDENTIFICATION

A. All valves shall be tagged with a numbered tag.

B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.

C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size, manufacturer and service.

D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in the main fire protection riser room. Additional copies shall be provided in each copy of the O&M manuals.

END OF SECTION

DIVISION 21 SECTION 211003
WATER BASED FIRE SUPPRESSION SYSTEM - SPRINKLERS
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SECTION 211003 - WATER BASED FIRE SUPPRESSION SYSTEM-SPRINKLERS & STANDPIPES

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. REFERENCE

A. The conditions of the Contract and General Requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 21 Section, *Common Work Results for Fire Protection* and Division 01 Section, *General Requirements.*

B. Submit complete shop drawings of all equipment utilized with the system in accordance with Division 21 Section, *Common Work Results for Fire Protection*. Submittals shall include but not be limited to the following fire protection system and accessories:

•Ball Drip Valves
•Fire Department Siamese Connection
•Pressure Sensing Devices, Valves
•Alarm Check Valves
•Pressure/Vacuum Gauges
•Inspector's Test Station
•Eccentric Reducers
•Pressure Switches
•Valves and Piping
•Backflow Preventers
• Flow Switches
•Tamper Switches

•Main Drains
•Auxiliary Drains
•Blind Flange with Escutcheon

C. Provide sprinklers, piping and associated equipment complete and ready for operation. Equipment materials, installation, workmanship, fabrication, assembly, erection, examination, inspection, and testing shall be in accordance with NFPA-13, NFPA-70, NFPA-72E, and NFPA-101 . Devices and equipment for fire protection service shall be U.L listed or FM approved.

D. All of the equipment and devices shall be included within the project Operations and Maintenance Manuals.

E. Refer to Division 21 Section, *Fire Protection Pipes, Valves, and Fittings* for pipe materials.

F. Fire Protection Systems design, equipment and installation shall comply with the Delaware State Fire Prevention Regulations, latest edition including all Annexes and Addendums.

1.3. DESCRIPTION

A. Provide all facilities, labor, materials, tools, equipment, appliances, transportation, supervision, and related work necessary to complete the work specified in this Section and as shown on the drawings. The work shall be performed by a licensed sprinkler contractor only. All equipment, piping, devices, and valves shall be sized based on hydraulic calculations. Include a 10 psig safety factor with hydraulic calculations.

B. Layout sprinkler system complete and size all fire protection piping in accordance with requirements of the National Fire Protection Association and the State Fire Marshal. System shall be designed for occupancy as required by applicable codes. Conceal fire protection piping in finished spaces unless indicated otherwise. System drains and inspector's test shall not be located in finished spaces.

C. Sprinkler equipment and work shall conform to requirements of National Fire Protection Association Standard No. 13 and No. 24. In addition, all work shall conform to requirements of all codes and regulations of authorities having jurisdiction over this work, including, but not limited to, State Fire Marshal, County Fire Marshal, Life Safety Codes and International Code, and Insurance Underwriter.

D. Preliminary Shop Drawing: Prior to preparing detailed working drawings for submission to State Fire Marshal, submit preliminary sprinkler system layout to the Architect for review and approval. Show all finished ceilings, light fixtures, air diffusers and other ceiling mounted devices. Coordinate sprinkler head types and locations with ceiling types. All sprinkler heads in acoustic tile ceilings shall be centered in the tile.

E. The fire protection contractor shall prepare dimensioned and detailed working drawings, specifications, and hydraulic calculations and submit same to the State Fire Marshal and/or County Fire Marshal for review and approval. Prior to submission to the Fire

Marshal, the Fire Protection Contractor shall have all fire protection drawings, submittals, calculations reviewed and approved by a registered Fire Protection Engineer or a level III Nicet Technician. One set of these approved documents shall be provided to the Engineer for record purposes. All costs related to changes required to obtain the Fire Marshal's or Insurance Underwriters' approval shall be the responsibility of the contractor.

F. Manufactured equipment and materials shall be submitted to the Engineer for review and approval, in accordance with the requirements of Division 21 Section, *Common Work Results for Fire Protection.*

G. Hydraulic calculations should be based on an available water supply as indicated on the Contract Drawings.

H. Hydraulic calculations shall include a 10 psig safety factor to account for pipe aging and deterioration of water supply.

I. For small areas subject to freezing (loading dock, exterior canopy, etc.), Contractor shall provide and install freeze proof heads, piping, control valves, tamper switches, test stations, (backflow preventers, expansion chambers, fill cup, drain valve) etc., as required by NFPA-13 and the authority having jurisdiction. Glycol loops shall be acceptable at contractor's option subject to the approval of the Authority having jurisdiction.

J. Where combustible construction materials are located above ceilings, provide above ceiling fire protection in accordance with N.F.P.A-13.

1.4. DELIVERY, STORAGE AND PROTECTION

A. Refer to Division 01 Section, *General Requirements*: Transport, handle, store, and protect products.

B. Accept equipment and devices on site in factory packing. Inspect for damage. Comply with manufacturer's rigging and installation instructions for all equipment.

C. Protect components from physical damage including effects of weather, water, and construction debris.

D. Provide temporary inlet and outlet caps, and maintain in place until installation.

1.5. EXTRA MATERIALS

A. Provide extra sprinklers under provisions of NFPA-13. Provide suitable wrenches for each sprinkler type and metal storage cabinet.

1.6. PERMITS FROM THE AUTHORITY HAVING JURISDICTION AND FEES

A. Pay all permits, fees, and charges required for this work.

1.7. HYDRANT FLOW TESTS

A. Where hydrant flow test data is not shown on the contract documents, or where required by the Owner, authority having jurisdiction, or Engineer, the Fire Protection Contractor shall perform a hydrant flow test.

B. The hydrant flow test shall be performed by the Fire Protection Contractor in the vicinity of each building at no additional cost to the Owner.

C. Where practical, tests shall be performed between 9:00 a.m. and 5:00 p.m. on a normal working day during summer. If conducting the test is impractical during these hours, then a local Fire Department representative shall be present to "observe" the test during "off peak" hours and to acknowledge the correctness of results.

D. The tests shall be submitted for review prior to submitting any hydraulic calculations. The test data shall contain the following:

1. Date of the test
2. Who performed the test and who was present.
3. Site plan indicating locations and diameters of water mains and locations of the hydrants tests.
4. Grade elevation of the hydrant tests
5. Static pressure in psig
6. Flow in GPM
7. Residual pressure in psig
8. Hydrant butt size in inches
9. Hydrant coefficient

1.8. ALTERNATES

A. Refer to Division 01 Section, *Alternates* - Alternates for description of work under this section affected by alternates.

1.9. LEED REQUIREMENTS

A. Refer to Division 01 Section, *LEED Requirements* for description of work under this Division affected by LEED Requirements.

PART 2. PRODUCTS

2.1. SPECIALTIES

A. All sprinkler heads shall be U.L. listed and shall be of the same manufacturer throughout the building.

B. Piping shall be in accordance with Division 21 Section, *Fire Protection Piping, Fittings, and Valves, etc*. All exposed fire protection piping in unfinished areas shall be painted with red epoxy paint. White letters shall identify piping and indicate direction of flow. Exposed fire protection piping within finished areas shall be painted in color as determined by the Architect.

C. Shut-off valves shall be UL approved O.S. and Y. double disc gate valves or UL/FM approved grooved end butterfly valves.

D. Check valves shall be swing check type or spring-loaded type UL approved for the application.

E. Siamese fire department connection shall be Potter-Roemer 5750 Series, or approved equal, with individual drop clapper valves, plugs, and chains on each connection. Exposed parts shall be polished chrome plated. Threads shall match local Fire Department specifications. Where required by local Fire Department, provide Storz type Siamese connection. Escutcheon shall be lettered "AUTO SPRINKLER", as required. Locate as shown on drawings and connect to main fire line through check valve with ball drip. Discharge ball drip drain line as indicated on contract drawings.

F. Coordinate the fire protection systems with the fire alarm system specified under Division 26. Provide alarm initiating devices with proper contact arrangement. All electrical wiring shall be furnished and installed under Division 26.

G. Flow control valve, alarm switches and valve supervision shall be furnished and installed under this Division. All wiring shall be accomplished by the electrical contractor, under Division 26. Provide any additional flow control valves, alarm switches, tamper switches and flow switches required by NFPA-13, but not indicated on contract drawings. Coordinate with the alarm system and electrical subcontractor.

H. Pipe and fittings shall meet the requirements of NFPA 13 and NFPA-24.

I. Wet pipe alarm check valve shall be Central Model F, Victaulic FireLock Series 751, or approved equal. Valve shall be UL listed and FM approved for sprinkler systems with 300 psig maximum working pressure. Provide complete valve trim package including all necessary valves, gauges, fittings, nipples and alarm test. Valve internal components shall be replaceable without removing the valve from the installed position. Valve shall be installed in the vertical position only.

J. Retard Chamber shall be Central Model F or Victaulic Series 752. Retard Chamber shall be UL listed and FM approved. Chamber shall prevent false alarms with ordinary city water pressure surges.

K. Water motor alarm shall be Central Model F-1 or Victaulic Series 760. Alarm shall be UL listed and FM approved. Alarm shall be hydraulically driven and tested 100 percent at low flow, 5 psig. Gong assembly and motor housing shall be finished with corrosion resistant, red enamel. Furnish unit with nylon bearings and inlet strainer. At contractor's option install electric gong. Provide power and control wiring under this Division of specifications.

2.2. SPRINKLER HEADS

A. Suspended or Drywall Ceilings:

1. Manufacturer: Central, Viking, Grinnell, Reliable, Gem, Victaulic, or approved equal.
2. Sprinkler heads in suspended or drywall ceilings shall be Central Model AC or Victaulic Model V38 concealed quick response sprinkler or approved equal. Cover plate shall be finished with a polyester baked enamel finish. Color selection by Architect. Provide cover assembly with each head. Frangible glass bulb shall be temperature rated for specific area hazard.

B. Exposed Area Type:

1. Manufacturers: Central, Viking, Grinnell, Reliable, Gem, Victaulic, or approved equal.
2. Sprinkler heads in unfinished or exposed areas shall be Central Model A, Victaulic Model V27, or approved equal. These sprinklers shall be standard, ½ inch upright, pendant or conventional where required. Provide guards where hereinafter indicated. Sprinklers shall be brass with frangible glass bulb temperature rated for specific area hazard. Provide standard brass, screw on flat escutcheon plate.

C. Sidewall type:

1. Manufacturers: Central, Viking, Grinnell, Reliable, Gem, Victaulic, or approved equal.
2. Sidewall sprinklers shall be Central Model GB-QR or Victaulic Model V27 semi-recessed horizontal sidewall type with matching screw on escutcheon plate. Sprinkler and escutcheon plate finish shall be chrome plated. Frangible glass bulb shall be temperature rated for specific area hazard.

D. Dry Sprinklers:

1. Manufacturers: Central, Viking, Grinnell, Reliable, Gem, Victaulic, or approved equal.
2. Sprinkler heads for areas subject to freezing (walk-in boxes), small loading docks, small canopies, and similar spaces shall be Central Model A-1 or Victaulic Model V36 dry sprinkler or approved equal. Dry sprinkler shall be standard or expose pendant type with matching escutcheon plate. Sprinkler and escutcheon plate shall be chrome plated. Frangible glass bulb shall be temperature rated for specific area hazard. Length of heads shall be as required to suit field conditions. Provide adjustable surface mounted escutcheon plate with each head. Provide flush ceiling plate. For small systems, per NFPA-13, glycol loops shall be acceptable at Contractor’s option, subject to the approval of the authority having jurisdiction.

E. The temperature rating of the sprinklers shall be as required by N.F.P.A.-13 and or the authority having jurisdiction.

F. All sprinkler heads installed in lay-in ceiling tiles shall be located in the center of the tile to provide a symmetrical, aesthetic and neat appearance. All sprinkler heads installed in bulkheads, recesses, and soffits shall be centered to provide a symmetrical, aesthetic and neat appearance.

G. Provide extended escutcheons in rooms with surface mounted lighting fixtures.

H. Additional heads shall be furnished as required by NFPA-13. The heads shall be in a cabinet designed to hold the heads and include one sprinkler head wrench for each type of sprinkler. Cabinet shall be mounted where indicated in the field.

I. Head guards shall be provided in mechanical spaces, penthouses, janitors' closets, electrical rooms, storage areas, elevator shafts, and elevator machine rooms. Finish for head guards in finished spaces shall be selected by Architect.

J. Provide high temperature sprinkler heads for use adjacent to kilns, skylights, autoclaves, or other high temperature areas.

K. Sprinkler escutcheons and guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.

2.3. FLEXIBLE SPRINKLER DROPS

A. Stainless steel Sprinkler Fittings

1. Manufacturer: Victaulic AquaFlex®

2. In lieu of rigid pipe offset for concealed locations only, or return bends for sprinkler drops, the Victaulic AquaFlex® stainless steel, multiple-use, sprinkler fitting system may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop systems hall consist of a braided or unbraided (corrugated) type 304 stainless steel flexible tube, a zinc-plated steel 1" NPT male threaded nipple for connection to branch-line piping, and a zinc-plated steel reducer with ½" or ¾" NPT female thread for connection to the sprinkler head. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket. The braided drop system is FM approved for sprinkler service to 200 psi and can be installed without the use of tools, and the unbraided system is UL listed for sprinkler services to 175 psi.

2.4. SIGNS

A. Provide 9 inch x 7 inch signs suspended from control valves which indicate the purpose of the valve and its normal position, Central Type A or approved equal.

B. All control, drain, and test connection valves shall be provided with signs indicating purpose.

C. Signs shall be fabricated of an approved material, painted red with white lettering.

D. Signs shall have typed labels. Handwritten labels shall not be acceptable.

2.5. DRAINS

A. The sprinkler systems shall be arranged to be completely drainable. Means of drainage shall be provided with adequate protection from freezing.

B. Drain valve may be combined with sprinkler alarm test valve and sight glass, G/J Innovations Sure-Test or approved equal. Valve shall be UL listed with positive off handle for off, test or drain, integral sight glass, orifice size equal to smallest sprinkler orifice and full 1 inch drain.

2.6. ALARM DEVICES

A. Approved water flow switches shall be installed to activate the fire alarm, and annunciate sprinkler flow at a minimum on each floor, each system riser, where indicated on the contract documents and where required by N.F.P.A. or the authority having jurisdiction. Conductors shall be provided under the electric division to provide fire alarm, and annunciation. Activation of the sprinkler system by one 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.

B. All valves controlling water supply for sprinklers shall be electrically supervised in accordance with requirements of NFPA 13 and 72A, and provided under this Division. Provide separate valve chart for all fire protection valve indicating valve type, normal position, size, location and type of supervision insert in O&M manual and mount additional copies in fire pump room and mechanical rooms.

C. Valve tamper switches shall be Model OSY2 as manufactured by System Sensor or Model OSYSU-A2 as manufactured by Potter Electric Signal Company or approved equal. The valve tamper switches shall monitor the open position of all OS&Y gate valves. Each tamper switches shall contain two sets of single pole double throw, Form C contacts. All valve tamper switches shall have tamper resistant covers that upon removal of the cover will cause the switches to operate. Tamper switches shall be suitable for 125/250 VAC @ 15 AMPS. All tamper switches shall be U.L. listed and F.M. approved.

D. Pressure type flow switches shall be Model EPS10 as manufactured by System Sensor or Model PS10-2 as manufactured by Potter Electric Signal Company or approved equal. Each pressure type flow switch shall contain two sets of single pole double throw switch contacts. All pressure type flow switches shall have tamper resistant covers that upon removal of the cover will cause the switches to operate. Pressure type flow switches shall be suitable for 125/250 VAC @ 10 AMPS. All pressure type flow switches shall be U.L. listed and F.M. approved.

E. Vane Type waterflow switch with retard shall be WFD Series as manufactured by System Sensor or Model VSR-F as manufactured by Potter Electric Signal Company or approved equal. The VAC type waterflow switches shall contain two single pole, double throw

form C, snap return switches. All Vane type waterflow switches shall have tamper resistant covers that upon removal of the cover will cause the switches to operate. Vane type waterflow switches shall be suitable for 125/250 VAC @ 10 AMPS. All vane type waterflow switches shall be U.L. listed and F.M. approved.

2.7. GAUGES

A. A listed 3 ½ inch dial spring pressure gauge shall be connected to the top of each standpipe. Gauges shall be located in a suitable place to prevent freezing. Each gauge shall be controlled by a valve having arrangement for draining.

B. Listed pressure gauges with connections not smaller than ¼ inch shall be installed at the system main drain, at each main drain associated with a floor control valve, and above and below each alarm check-valve.

C. All pressure gauges shall be listed and shall have a maximum limit not less than twice the normal working pressure at the point where installed. They shall be installed to permit removal and shall be located where they will not be subject to freezing.

2.8. DOUBLE DETECTOR CHECK VALVE BACKFLOW PREVENTER (FIRE PROTECTION SYSTEM)

A. The sprinkler system backflow preventer shall be provided under this Division and coordinated with Plumbing Contractor. Backflow preventer shall be sized for sprinkler demand to limit pressure drop to 5 psig.

B. Backflow preventers for Fire Protection Systems shall be ASSE/AWWA-1015 approved, double detector check-valve backflow preventer assemblies at sprinkler system water service connections. Units shall be specifically listed for Fire Protection use. Units shall be double detector check valve as manufactured by Watts 709 DCDA, Ames, Conbraco, Wilkens, or approved equal with OS&Y Gate valves, U.L. listed, F.M. approved, NSF-61 approved. Units shall be suitable for minimum 175 psi working pressure. Backflow preventers shall be factory tested at two (2) times the working pressure encountered or as required by N.F.P.A. Backflow preventer shall be capable of withstanding test pressures per N.F.P.A.

C. Backflow preventer shall be factory finished with epoxy coated paint or 304 type stainless steel.

D. Pipe any discharge openings full size, through air gap fittings, to nearest floor drain. Maintain clearances for servicing as required by Plumbing Code and authority having jurisdiction. Discharge piping shall be Type L copper pipe.

E. Provide and install tamper switches on all backflow preventers OS&Y gate valves and butterfly valves. Backflow preventer shall be installed between 12 inches and 60 inches above finished floor. Provide 18 inch clearance around backflow preventer for service and maintenance.

F. Unit shall include auxiliary piping with approval backflow preventer and water meter. Meter shall indicate flow in gallons per minute.

2.9. AUTOMATIC BALL DRIP VALVES

A. Provide and install automatic ball drip valves at the Fire Department connection. Discharge ball drip valves to closest floor drain or building exterior as required, with suitable air gap. Automatic ball drip valves shall be ITT-AC Pump or approved equal.

2.10. VALVES

A. Provide and install control valves as indicated on contract drawings and as required by N.F.P.A.-13. Gate valves shall be listed O.S. & Y. type. All control valves shall be supervised open. Supervision shall be as required by N.F.P.A.-13. Victaulic Series 705 and 765 grooved end butterfly valves shall be supervised in the open position and Victaulic Series 707 and 766 shall be supervised closed, for fire pump metering test lines for NFPA 20 and rooftop test units, as well as pressure reducing valve by-pass lines per NFPA-14.

2.11. BLIND FLANGE FOR FORWARD FLOW TESTING OF BACKFLOW PREVENTER

A. A blind flange with normally closed control valve shall be provided for use in forward flow testing of backflow preventer. Blind flange shall be sized to flow entire system demand in accordance with NFPA-13 and NFPA-25, latest edition. Control valve shall be monitored with tamper switch.

B. Identify and label blind flange "Backflow Preventer Test Connection" to differentiate fitting on exterior wall from Fire Department connection.

C. Install ball drip in test pipe to allow drainage and prevent freezing.

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

A. Install equipment in accordance with manufacturer's instructions.

B. Where required, install buried shut-off valves in valve box. Provide post indicator.

C. Provide approved double check valve assembly at sprinkler system water source connection.

D. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent Siamese connectors to allow full swing of fire department wrench handle.

E. Locate outside alarm gong on building wall.

F. Place pipe runs to minimize obstruction to other work.

G. Place piping in concealed spaces above finished ceilings.

H. Center sprinklers in two directions in ceiling tile and provided piping offsets as required.

I. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.

J. Flush entire piping system of foreign matter.

K. Install guards on sprinklers where subject to abuse and where specified.

L. Hydrostatically test entire system.

M. Test must be witnessed by Fire Marshal/authority having jurisdiction/ Owner's insurance underwriter/ Architect/Engineer.

N. Refer to plumbing floor plans for approximate locations of sprinkler zones control valve assemblies and routing of fire protection mains.

O. Locate inspectors test stations for sprinkler zones per NFPA-13. Provide and install drain piping from all approved terminations. Provide splash blocks for terminations outside. Splash block locations shall be approved by the Architects.

P. The fire protection contractor shall hydraulically prove the most remote area per NFPA-13.

Q. Coordinate locations of sprinkler heads with lights, diffusers, ceiling types, etc.

R. Hydrostatically test system at 200 PSI for 4 hours, per NFPA-13.

S. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

T. Provide dry pipe sprinklers at all loading docks, canopies, walk-in freezers, etc., as required by NFPA-13.

U. Refer to Architectural Drawings for exact location and extent of all fire rated walls and smoke barriers.

V. Grooved joint piping systems shall be installed in accordance with the manufacturer's (Victaulic) guidelines and recommendations. All grooved couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.

Gaskets shall be molded and produced by Victaulic. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.

3.2. INTERFACE WITH OTHER PRODUCTS

A. Ensure required devices are installed and connected as required to fire alarm system.

3.3. LAYOUT

A. Coordinate layout and installation of fire protection system with all other buildings structural, mechanical and electrical work. Locate sprinkler heads symmetrically with respect to ceiling tiles, lighting fixtures, registers, grilles, diffusers, etc. Provide piping offsets as required to maintain symmetry. Note that a preliminary sprinkler layout is to be submitted for review. Contractor is cautioned that sprinkler mains must be located to prevent conflict with other work and in any case, sprinkler contractor shall be responsible for coordination of his work with work of other trades.

B. Unless otherwise indicated, the entire building shall be protected throughout with a wet pipe sprinkler system.

3.4. WET PIPE SPRINKLER SYSTEM

A. System components shall include, but not be limited to flow control valves, electrical connections to central fire alarm system, Siamese fire department connection, check valves, main piping, branch piping, inspector's test, drains, sprinkler heads, ball drip valves, signs, etc. and all other incidental appurtenances as required.

3.5. VALVE INSTALLATION

A. Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

B. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

C. Alarm Check Valves: Install valves in vertical position for proper direction of flow, including bypass check valve and retard chamber drain-line connection.

3.6. CONNECTIONS

A. Connect water supplies to standpipes and sprinklers. Include backflow preventers.

B. Install ball drip valves at each check valve for fire department connection. Drain to floor

drain or outside building.

C. Connect piping to specialty valves, specialties, fire department connections, and accessories.

D. Connect alarm devices to fire alarm.

3.7. COMMISSIONING

A. Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.

B. Verify that specified tests of piping are complete.

C. Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.

D. Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.

E. Verify that potable-water supplies have correct types of backflow preventers.

F. Verify that fire department connections have threads compatible with local fire department equipment

G. Fill wet-pipe sprinkler piping with water.

H. Energize circuits to electrical equipment and devices.

I. Adjust operating controls and pressure settings.

J. Coordinate with fire alarm tests. Operate as required.

3.8. DRAINS

A. The sprinkler system shall be arranged to be completely drainable. Means of drainage shall be provided with adequate protection from freezing.

3.9. TESTS

A. The sprinkler systems installation shall be hydrostatically tested, inspected, and approved, in accordance with NFPA Standard No. 13, NFPA Standard No. 14, and NFPA Standard No. 25. Test certificate shall be forwarded to the Office of the State Fire Marshal and the Architect as proof of compliance.

B. Tests shall be performed in accordance with the requirements of the Office of the State Fire Marshal and shall prove the systems to be adequate and satisfactory in every respect. All tests shall be performed in the presence of the State Fire Marshal or his

representative.

C. Any deficiencies revealed by these tests shall be corrected and the systems shall be retested until acceptable results are obtained.

3.10. AS-BUILT DRAWINGS & PROJECT CLOSEOUT

A. Provide separate as-built drawings of all fire protection systems meeting requirements of General Mechanical Requirements hereinbefore specified.

B. At the completion of the work, provide a sealed plan of the building indicating the locations of all control valves, low point drains, flow switches, and Inspectors Test Stations. The plan shall be neatly drawn and color coded to indicate the portion of the building protected by each system, framed under glass and permanently mounted on the wall adjacent to the system header.

C. Include manufacturers literature, cleaning procedures, replacement parts, lists, and repair data for equipment.

D. Include manufacturers' instructions, start-up data, troubleshooting, check lists for all equipment.

3.11. WARRANTY

A. The Contractor's attention is directed to the warranty obligations contained in the Article of the General Conditions of the specifications entitled "warranty".

3.12. OWNER TRAINING

A. Upon completion of the project, furnish a complete copy of NFPA-25 to Owner. Provide correspondence indicating that the pamphlet has been turned over to the Owner.

1. Contractor shall provide at least eight (8) hours of training to the Owner on the proper inspection, testing, and maintenance of the installed fire protection system.
2. Schedule training with the Owner through the Architect and/or Engineer with at least seven (7) days prior notice.

3. A Victaulic factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

END OF SECTION

DIVISION 22 SECTION 220500
COMMON WORK RESULTS FOR PLUMBING
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SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2. SUMMARY

A. All work under Division 22 is subject to the Division 01,*General Requirements, the General Conditions and Supplementary Conditions.*

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all plumbing work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 22 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.3. PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the Division 01,*General Requirements* of the specification.

1.4. EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.5. CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 22 shall be fully qualified and acceptable to the Architect and Owner. Submit the following evidence when requested:

1. A list of not less than five comparable projects which the Contractor completed.

2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.

3. Local and/or State License, where required.

4. Membership in trade or professional organizations where required.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.6. MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.7. FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.8. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

B. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers

C. ASME - American Society of Mechanical Engineers

D. ASPE - American Society of Plumbing Engineers

E. ASTM - American Society for Testing and Materials

F. AWWA - American Water Works Association

G. CS - Commercial Standard

H. EPA - Environmental Protection Agency

I. FM - Factory Mutual

J. IBC - International Building Code

K. IEEE - Institute of Electrical and Electronics Engineers

L. MSSP - Manufacturers Standards Society of the Valve and Fittings Industry

M. NEC - National Electrical Code

N. NEMA - National Electrical Manufacturers Association

O. NSF - National Sanitation Foundation

P. UL - Underwriters' Laboratories

Q. All plumbing equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled *Codes and Standards*.

1.9. SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6)copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the

proposed item. The contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

I. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.10. SHOP DRAWINGS

A. Prepare and submit shop drawings for all plumbing equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. <u>Items and Systems</u>

Access Doors/Panels including layout and location
Automatic Temperature Control System and Equipment as it relates to plumbing system

Backflow Preventers
Coordinated Drawings
Direct Buried Piping
Domestic Hot Water Storage Tank
Domestic Water Expansion Tanks
Drip Pans
Emergency Shower & Mixing Valves
Equipment Rails
Exterior Equipment/Piping Supports
Fire Stopping - Methods and Materials
Floor and Roof Drains
High/low Mixing Valves
Hybrid Water Heater
Hose Bibbs and Wall Hydrants
Identification System
In-Line Circulators
Material and Equipment List
Operations and Maintenance Manuals
Pipe Enclosures
Pipe Materials Including Itemized Schedule
Plumbing Fixtures & Trim
Preliminary Testing and Balancing Report
Pressure Relief Valves
Pressure Regulating Valves
Pumps
Roof Curbs
Strainers
Test Certificates
Thermal Solar Gravity Drainback System
Thermal Insulation Materials Include Table Summary
Thermometers and Gauges
Thermostatic Mixing Valves
Vacuum Breakers
Valves
Vibration Isolation Materials
Water Meters
Weatherproof Assembly Components
Wiring Diagrams, Flow Diagrams and Operating Instructions

E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked *Reviewed* or *Comments Noted*. After the proposed materials have been reviewed, no substitution will be permitted except where approved by theArchitect.

1.11. SUPERVISION AND COORDINATION

A. Provide complete supervision, direction, scheduling, and coordination of all work under

the Contract, including that of subcontractors.

B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, equipment, and other work performed under Division 22.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Coordinate electrical work required under Division 22 with that under Division 26. Coordinate all work under Division 22 with work under all other Divisions.

E. Supply services of an experienced (10 years minimum) and competent Project Manager to be in constant charge of work at site.

F. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.

G. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the intent of the contract documents.

H. Coordinate installation of large equipment requiring positioning before closing in building.

1.12. CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 22. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

1.13. PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where plumbing vents or other pipes penetrate roofs, flash pipe with Stoneman*Stormtite*, Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing

sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install roof drains, curbs, and vent assemblies specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.14. CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 22. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.15. EXCAVATION AND BACKFILLING

A. GENERAL

1. Perform all necessary excavation, or installation of work under Division 22, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish,

roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.

3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.16. DRIVE GUARDS

A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.

B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.17. VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, or piping to building structure. See Division 23Section,*Vibration Controls for HVAC, Plumbing and Fire Protection.*

1.18. ALTERNATES

A. Refer to Division 01, -*Alternates* for description of work under this section affected by alternates.

1.19. FASTENERS

A. All fasteners located in public spaces including classrooms, corridors, lobbies, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

1.20. DEFINITIONS

A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.

E. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction.

F. *Exposed* means not installed underground or *concealed* as defined above.

G. *Invert Elevation* means the elevation of the inside bottom of pipe.

H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

I. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

J. *SCR*: Silicon Controlled Rectifier: Solid state switching device to provide fast, infinitely variable proportional control.

K. *ECM*: Electronically Commutating Motor.

L. *Building Line:* Exterior wall of building.

1.21. MINIMUM EFFICIENCY REQUIREMENTS

A. All plumbing equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

B. All piping and equipment insulation shall comply with ASHRAE Standard 90.1, latest edition.

C. All service water/heating equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

D. All plumbing devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

1.22. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

1.23. SYSTEM INTEGRATION

A. For all plumbing equipment specified to be provided with packaged controls and interfaced with the automatic temperature control system, provide system integration between the equipment manufacturer and the automatic temperature control subcontractor.

B. Plumbing equipment submittals requiring system integration as defined above must identify all required system integration points.

C. Plumbing equipment manufacturers must coordinate with ATC subcontractor regarding system integration prior to submitting on the equipment.

D. A system integration meeting must be arranged by the Mechanical Contractor and include, but not be limited to the systems integrator for the plumbing equipment manufacturer and the ATC Subcontractor. This portion of systems integration must occur prior to plumbing equipment being delivered to the project.

E. Once the plumbing equipment is on site, a second systems integration meeting must be arranged by the Mechanical Contractor to coordinate the packaged controls with the ATC system. The plumbing equipment manufacturer's representative familiar with system integration and the ATC subcontractor familiar with programming must be present.

F. A final system integrations meeting shall occur once all equipment is in place and ready for operation. The Mechanical Contractor, the plumbing equipment systems' integrator, and the ATC Subcontractor shall meet on site to jointly program, schedule, verify points, interlock devices, and fully set up all systems integration components.

G. All systems integration coordination, programming, and graphics must be completed prior to requesting commissioning and/or inspections by the Engineer of Record

PART 2. ELECTRICAL REQUIREMENTS

2.1. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 22 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 22. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 22.

B. All electrical work performed under Division 22 shall conform to the applicable requirements of Division 26 and conforming to the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA &International Building Code.

C. Provide wiring diagrams with electrical characteristics and connection requirements.

D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.

G. Motors located in exterior locations, wet air streams and outdoors shall be totally enclosed weatherproof epoxy-treated type.

H. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

I. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.

J. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.2. MOTORS AND CONTROLS

A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG l.

C. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.

2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR^2 of the driven equipment to operating speed.
3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.
4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.
5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

D. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of plumbing equipment. When approved by the Engineer, deviations from the specifications will be permitted as follows:

1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.
2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.

E. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.

F. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR

1HP and above to	85.5 percent	84 percent
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent
5HP	89.5 percent	87 percent
7½ HP	91 percent	86 percent
10HP	91.7 percent	85 percent
15HP	93.0 percent	85 percent
20HP	93.0 percent	86 percent
25HP	93.6 percent	85 percent
50HP	94.5 percent	88 percent
60 HP	95.0 percent	90 percent
75HP	95.0 percent	90 percent
100 HP	95.4 percent	90 percent
125 HP	95.8 percent	95 percent
150 HP and above	96.0 percent	95 percent

G. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

H. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated.

I. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.

J. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.

2.3. MOTOR INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.

C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.

2.4. WIRING DIAGRAMS

A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.

B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.

C. Provide wiring diagrams for all major plumbing items of equipment to electrical contractor and ATC subcontractor for coordination.

PART 3. EXECUTION

3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.2. SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or

fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Concrete housekeeping pads and foundations shall be not less than 4 inches high and shall extend a minimum of 6 inches beyond equipment bases. Provide wire-mesh reinforcement; chamfer exposed edges and corners; and finish exposed surfaces smooth.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4. PROVISIONS FOR ACCESS

A. The contractor shall provide access panels and doors for all concealed equipment, valves,strainers,dampers,filters,controls,control devices,cleanouts,traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.5. PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 22 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by theArchitectand conform to ANSI Standards.

H. All exterior roof mounted equipment, piping and vents shall be painted to match roof in color as selected by Architect.

I. All exposed piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

J. All exposed piping, equipment, etc., in Mechanical Rooms, Penthouses, Fire Pump Rooms, Mezzanines, and Storage where PVC jacketed shall not require painting. Label and identify and color code as specified.

3.6. CLEANING OF SYSTEMS

A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.

B. Flush piping in re-circulating water systems to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of service company used.

C. Maintain strainers and dirt pockets in clean condition.

D. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

E. Leave systems clean, and in complete running order.

3.7. COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.8. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.9. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

D. Do not use plumbing systems for temporary services or temporary conditioning during construction. Refer to Division 01 section *"Temporary Facilities and Controls"* for temporary plumbing during construction.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged.

C. All items of equipment, including motor startersand disconnects shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal).

D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Operations and Maintenance Manuals* as hereinafter specified.

E. All lines piping installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and service. Refer to Division 22Section,*Plumbing Piping, Fittings, Valves, Etc*. Color code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for plumbing identification. Submit samples of equipment identification cards, piping labels, labels, and valve tags to Engineer for review prior to installation.

G. Provide at least 8hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section,*Instrumentation and Controls of HVAC and Plumbing Systems*.

H. Contractor shall demonstrate Sequences of Operation of all plumbing equipment in presence of Owner's representative, Engineer, and ATC subcontractor.

3.11. WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by piping or conduit under Division 22 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 07Section,*Fire Protection, HVAC and Plumbing Penetration Firestopping*.

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07Section,*Fire Protection, HVAC and Plumbing Penetration Firestopping.*

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.

E. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.12. RECORD DRAWINGS

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architectone complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders,

etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the*General Conditions and Supplementary Conditions.*

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.

C. The contractor guarantees for a two yearperiod from the time of final acceptance by the Owner.

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the *Operations and Maintenance Manuals*.

B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have preparedsix(6)copies of the *Operations and Maintenance Manuals* and deliver these copies of the manuals to the Owner. The manuals shall be as specified herein. The manuals must be approved and will not be accepted as final until so stamped.

B. The manuals shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual*

Delaware Technical & Community College Sustainable Energy Training Center – Plumbing Systems. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Catalog data on each piece of plumbing equipment furnished.
3. Maintenance operation and lubrication instructions on each piece of plumbing equipment furnished.
4. Complete catalog data on each piece of plumbing equipment furnished including approved shop drawing.
5. Manufacturer's extended limited warranties on equipment including but not limited to water heaters, storage tanks, and solar panels.
6. Chart form indicating frequency and type of routine maintenance for all plumbing equipment. The chart shall also indicate model number of equipment, location and service.
7. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
8. Provide supplier and subcontractor's names, address, and phone number.
9. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
10. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass. .
11. Copy of the approved balancing report for plumbing equipment/system.
12. Access panel charts with index illustrating the location and purpose of access panels.
13. Approved Healthand Plumbing and Electrical Certificates.
14. Start-up reports for equipment.
15. Insert color graphic with embedded parameters for ATC system into Record and Information Booklet.

D. Submit *Operations and Maintenance Manuals* prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that *Operations and Maintenance Manuals* reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:

1. Complete Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural

amenities.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, and piping in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

3.17. PIPING SYSTEMS TESTING

A. The entire new plumbing piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	**TEST PRESSURE**
Domestic Water & Coil Drain Piping	100 psi
Sanitary & Storm Water Piping	As specified below
Domestic Pre-Heat Water Piping	100 psig
Solar Supply/Return Piping	50 psig
Emergency Fixture, Tepid Water	100 psig

B. All storm, waste, vent and water piping shall be tested by the Contractor and approved by the Engineer before acceptance. All storm, soil, and waste piping, located underground, shall be tested before backfilling. The costs of all equipment required for tests are to be included in the contract price.

C. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest stack above or at the roof. The system shall hold this water for thirty (30) minutes without showing a drop greater than 1inch. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure. The pressure shall be maintained for thirty (30) minutes. All testing shall be in accordance with the local Plumbing Code and witnessed by the Plumbing Inspector or authority having jurisdiction.

D. Upon completion of roughing-in and before setting equipment and fixtures, the entire new water piping system shall be tested at a hydrostatic pressure of not less than one hundred (100) pounds per square inch gauge and proven tight at this pressure. Where a

portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.

E. Testing and acceptance thereof shall be in accordance with localrequirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

3.18. EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve this contractor of any responsibility for improper equipment operation.

END OF SECTION

DIVISION 22 SECTION 220505
PLUMBING PIPING, FITTINGS AND VALVES
TABLE OF CONTENTS

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. SUMMARY

A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 22 Section, Common Work Results for Plumbing and Division 01, *General Requirements*.

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

1.3. SYSTEM DESCRIPTION CONDITIONS

A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.

B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and International Building Code (IBC).

C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus

connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

F. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.

G. Use spring loaded "silent" check valves on discharge of all pumps.

H. Use 3/4 inch (20 mm) ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

I. At all runout piping serving equipment, use swing joints with elbows to prevent excessive movement of piping due to expansion.

1.4. QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulation. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

C. Welders Certification: In accordance with ASME Section 9.

D. Maintain one copy of each document on site.

1.5. DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under as hereinbefore specified.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

1.6. ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.7. EXTRA MATERIALS

A. Provide one (1) repacking kit for each size valve.

1.8. ALTERNATES

A. Refer to Division 01 - *Alternates* for description of work under this section affected by alternates.

1.9. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements

PART 2. PRODUCTS

2.1. PIPE MATERIALS

A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.

1. Sanitary Underground - Within Building to 5 Feet Outside of Foundation Wall:

a). PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2. Sanitary and Vents Above Floor Inside Building:

a). Pipe & Fittings: Cast iron *No-Hub* pipe and fittings, shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute and listed by NSF International as compliant with CISPI 301, ASTM C564. Installation and support shall be in accordance with Cast Iron Soil Pipe Institute recommendation. Joints shall be made with neoprene gaskets and stainless steel clamp and shield assemblies listed by NSF International as compliant with CISPI 310. Sealing sleeve shall be polychloroprene (neoprene) based rubber sleeve conforming to ASTM C564.

b). Hubless Cast Iron Soil Pipe and Fittings

i. Hubless pipe and fittings must be listed by NSF International as compliant with CISPI 301.

ii. Manufacturers:

1) AB&I
2) Charlotte
3) Tyler

c). Medium Duty Shielding Coupling, ASTM C 1540, Type 304 Stainless Steel corrugated shield and bands, and polychloroprene (neoprene) based rubber sleeve conforming to ASTM C564.

i. Approved manufacturers:

1) Clamp-All
2) Mission Rubber Company
3) Anaco

3. Storm Water Below Grade or Under Building to Point 5 Feet from Building Line:

a). PVC Pipe: Schedule 40 DWV or cellular core. Fittings: Schedule 40 PVC, ASTM D 2665 or ASTM F891 socket fittings. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

4. Storm Water Above Floor Inside Building:

a). Pipe & Fittings: Cast iron *no-hub*, pipe and fittings, CISPI 301. Installation and support shall be in accordance with Cast Iron Soil Pipe Institute recommendations. Joints shall be made with neoprene gaskets and stainless steel clamp and shield assemblies listed by NSF International as compliant with CISPI 310.

b). Hubless Cast Iron Soil Pipe and Fittings

i. Hubless pipe and fittings must be marked with the Cast Iron Soild Pipe Institute and listed by NSF International as compliant with CISPI 301.

ii. Manufacturers:

1) AB&I
2) Charlotte
3) Tyler

c). Medium Duty Shielding Coupling, ASTM C 1540, Type 304 Stainless Steel corrugated shield and bands, and polychloroprene (neoprene) based rubber sleeve conforming to ASTM C 564.

i. Approved manufacturers:

1) Clamp-All
2) Mission Rubber Company
3) Anaco

5. Domestic Cold Water Outside of Building Below Ground or Under Building to Point 5 Feet from Building Line:

   a). Pipe: 2-1/2 inches & smaller, soft temper type *K*. ASTM B88 - No joints below grade except as approved by the Engineer.
   3 inches & larger, ductile iron pipe for water, ANSI 21.50 & 21.51 with double thickness cement mortar lining, ANSI 21.4.

   b). Fittings & Joints: wrought copper solder joint fittings, ANSI B16.22. Joints for copper piping shall be ASTM B32, SOLDER, grade 95TA.
   Cast iron pressure fittings, ANSI 21.10, Class 250. Mechanical specification for mechanical joint for cast iron pressure pipe & fittings ANSI A21.11. Joints for ductile iron pipe shall be AWWA C111, rubber gasket with 3/4 inch diameter rods.

6. Domestic Hot, Cold, and Recirc., Emergency Fixture Tempered Water, Solar Supply/Return, Water Piping Inside Buildings, Above Grade:

   a). Pipe or Tubing: 2 inches & smaller, all water lines soft temper Type *K* copper tubing below ground, hard temper Type *L* copper tubing above ground, ASTM B88.
   2-1/2 inches & larger, hot dipped galvanized steel A120, ASTM A53, Grade B, Schedule 40 steel, or hard copper tube, Type L with grooved ends; copper ground - end fittings; copper tubing, keyed couplings; and grooved joints.
   Provide dielectric fittings between steel and copper.

   b). Fittings & Joints: Copper tubing fittings and joints shall be solder type wrought copper - 95-5 silver solder or braze (lead and antimony based solders are prohibited). Galvanized steel pipe fittings and joints shall be ANSI B16.12 hot dipped galvanized threaded ends and 125 lb. galvanized cast iron fittings or 150 lb. galvanized malleable iron.

   c). Gate Valves: 2-1/2 inches & larger - OS&Y, IBBM flanged, 125 lb. standard solid wedge.
   2 inches & smaller - bronze solder end, bronze body, solid wedge, rising stem, 200 lb. w.o.g. non-shock. However, use brass valves only on all copper pipe.

   d). Ball Valves: Shut-off valves 2-inches and smaller shall be ball valves. Ball valves shall be 150 lbs, bronze body, standard port, 2 piece body, TFE seats with bronze trim. Ball valves shall be threaded end or solder end as required to accommodate piping. Ball valves shall be as manufactured by Conbraco, Crane, Apollo, Nibco, Watts or approved equal.

   e). Unions: 2-1/2 inches & larger - 150 lb. brass companion flanges.
   2 inches & smaller - wrought copper, ground joint solder ends.

   f). Check Valves: 2-1/2 inches & larger - IBBM, 125 lb. std. flanged bronze swing check, with metal disc; 2-inches and smaller - 125 lb. std. screwed or solder ends.

   g). Globe Valves: 2 inches and smaller, bronze body, bronze trim, rising stem, hand wheel, inside screw, renewable composition disc, solder ends, 150 lb, with back seating capacity.
   2 inches & larger: IBBM, 150 lb, bronze trim, rising stem, handwheel

OS&Y, plug type disc, flanged ends, renewable seat and disc.
Globe valves shall be Conbraco, Crane, Nibco, Milwaukee, Watts or approved equal.

h). Combination Shut-off/Balancing Valves:
Taco Circuit Setter, Bell & Gossett Circuit Setter Plus, Flowset Accuset, Gerand, or as approved equal, ½ inch-3 inches 300 lb. rated ball valve with bronze body/brass ball construction with glass and carbon filled TFE seats, in-line flow meter and balancing and shut-off valve with built in ball valve for flow adjustment. Valve shall have memory stop, calibrated nameplate, Schrader valve connections and preformed molded insulation. Valves shall be leaktight at full rated working pressure. Balance valve size shall be selected based on manufacturer's acceptable flow range and design flow rate. Pressure drop through combination shut off balance valves shall not exceed 5 feet of head at design flow rate.
Provide differential pressure gauge portable readout meters at 1 percent accuracy, 10 ft. length hoses, shut-off valves, vent valves, carrying case and balance valve calculator, Taco Model; 789, B&G R0-4, or as approved equal.

i). Extended Valve Stems: Provide and install round collar type extended valve stems on all valves installed in insulated piping. Valve stem and collar shall be selected to suit insulation thickness and maintain valve handles outside of insulation.

B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.

C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.

D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. PIPE HANGERS

A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260 for pipe ¾-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
3/4 & 1	6	5	3/8
1 - ½	6	8	3/8
2	8	8	3/8
2 – ½	10	9	½
3	12	10	½
4	14	12	5/8
5	14	12	5/8
6	16	14	3/4
8	18	16	7/8
10	20	18	7/8
12	20	18	7/8

B. Install hangers for cast-iron and storm water soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. PS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.
6. NPS 15 (DN 375): 60 inches (1500 mm) with 1-inch (25-mm) rod.
7. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

C. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

D. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with

insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.

E. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

F. Hangers for cold pipe sizes 2 inches (50 mm) and over: Carbon steel, adjustable, clevis.

G. Hangers for cold pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.

H. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.

I. Multiple or Trapeze hangers for hot pipe sizes 6 inches (150 mm) and over: Steel channels with welded spacers and hanger rod, cast iron roll.

J. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook

K. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp.

L. Vertical Support: Steel riser clamp.

M. Floor support for cold pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

N. Floor support for hot pipe sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

O. Copper pipe support: Carbon steel ring, adjustable, copper plated.

P. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

Q. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3. VALVES

A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer.

B. Check valves in base mounted pump discharges shall be of the vertical type and shall be Miller "non-slam" check valves or approved equal suitable for service intended. Check valves in circulator discharges shall be horizontal type.

C. Provide at each base mounted pump a suction diffuser of size and type shown on drawings. Units shall consist of a cast iron angle type body with inlet vanes, magnetic insert, and blowdown connection tapped gauge post, 125 psi ANSI flange and a combination stainless

steel diffuser strainer with 3/16-inch diameter opening for pump protection. Unit shall be equipped with a disposable fine mesh start up strainer which shall be removable after 30 days. Flow direction shall be from inside the strainer to outside for ease of service and cleaning. The body shall fit the pump and connecting pipe size. The unit shall be provided with an adjustable support foot to relieve piping strains from the pump suction. Suction diffuser shall be Taco "SD" Series Catalog 300-4.1, Bell and Gossett Model FLG, Armstrong, or approved equal.

D. Multi-purpose valve (non-slam check valve, throttling valve, shut-off valves and calibrated balancing valve) shall be provided at discharge side of each constant speed pump. The valve shall be of heavy-duty cast iron construction with standard ANSI flanged connections and rated for a maximum working pressure of 175 psig at 240^{o}F. The valve shall be fitted with a stainless steel stem or stem sleeve and brass seat with "O" ring seal. Valve shall be Taco "Plus One" Number 300-4.2, Bell and Gossett 3DS Triple Duty Valve, Armstrong, or as approved equal, and shall have check and plug valve features plus a memory stop with pointer and scale. Provide additional shut-off valve to allow servicing of check valve if a multipurpose valve is utilized in lieu of separate check, shut-off, and balance valve. Provide additional shut-off valve downstream of multi-purpose valve to allow servicing of multi-purpose check valve feature. Provide pre-manufactured, removable insulation covers for all multipurpose valves. Do not install check valves or multipurpose valves at the discharge of the solar lift pump.

2.4. STRAINERS

A. Strainers shall be of the basket or "Y" type and shall be heavy and durable, constructed of best grade gray iron with the bottoms drilled and plugged. Bodies shall have arrows clearly cast on the sides to show flow direction. Strainers shall be equipped with easily removable covers and brass sediment baskets made of brass not less than #22 gauge in thickness. Total area of basket perforations shall be not less than four times the cross section of the entering pipe. Flow shall be into basket, and then out through the perforations. Strainers shall be suitable for water or the intended fluid. Strainers 2 inches and smaller shall have threaded or solder ends, 2 inches and larger shall have flanged ends.

B. Strainer screens shall be stainless steel with perforations and shall be 1/16-inch for pipe sizes 5 inches and less, 1/8-inch (40 percent open area) perforations for pipe sizes 6-inch and greater.

C. Provide valved and capped (with chain) blowdowns in each strainer. Blowdown valves shall be Appolo 78-100/200 series or as approved equal.

D. Strainers shall be manufactured by Watts, Mueller, Armstrong, Yarway, Spirax/Sarco or as approved equal.

2.5. UNIONS, FLANGES, AND COUPLINGS

A. Unions in steel pipe 2-inches and smaller shall be malleable iron with brass inserted seats designed for a working pressure of 150 psig.

B. Unions in copper pipe 2-inches and smaller shall be sweat fittings with bronze seats designed for a working pressure of 125 psig.

C. Flanges for steel pipe over 2 inches shall be 150 psig, forged steel, slip on. Gaskets shall be 1/16 inch thick pre-formed neoprene.

D. Flanges for copper pipe over 2 inches shall be bronze. Gaskets shall be 1/16 inch thick preformed neoprene.

2.6. MANUAL AIR VENTS

A. Manual air vents shall be similar to the hereinafter specified gauge valves. Provide 1/4-inch size on ¾-inch pipe and smaller, ½ -inch size on 1-inch pipe and larger. Install at all high points of piping. Valves shall be Crane No. 88, or as approved equal, with threaded ends, bronze body, bronze or brass bonnet and bronze stem.

2.7. THERMOMETERS

A. Unless otherwise indicated, thermometers shall be ASTM E1, in a glass type, organic filled, 9-inch scale size, corrosion-resistant metal case, with "any-angle" mounting with positive locking device. Trerice Industrial Thermometers, Weksler Instruments, Ernst Gage Co., Miljoco, or approved equal. Insertion stem length shall suite the pipe size and configuration. Thermometer wells shall be brass with brass union hubs in copper and in ferrous piping. Where piping is insulated or otherwise covered, use wells with lagging extension. Where wells are installed in pipe tees at turns, increase pipe size so that well does not restrict flow. Accuracy shall be 2 percent.

B. Unless otherwise indicated, thermometer ranges shall be as follows:

1. Tempered water, Domestic cold water: 0 degrees F to 100 degrees F, 1 degrees F Division
2. Domestic hot recirc. and tempered water: 30 degrees F to 240 degrees F, 2 degrees F Division.
3. Tempered Water: 30 degrees F to 100 degrees F, 2 degrees F Division.

C. Provide heat conducting compound in wells.

D. At Contractor's option, light powered thermometers may be utilized in lieu of organic filled thermometers.

2.8. PRESSURE GAUGES

A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Trerice Model 600C; Weksler Instruments,

Ernst Gage Co., Miljoco, or as approved equal.

B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.

C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.

D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.

E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Trerice, RS1/RS6 by Wexler Instruments, Miljoco or as approved equal.

2.9. PIPING SPECIALTIES

A. Furnish and install flexible pipe connections, as specified and/or shown on the drawings, at suction and discharge connections of all base mounted and vertical in-line pumps, connections to air compressors, all vibrating equipment and elsewhere as shown. Pump flexible connections shall be utilized at pumps and hose kits at heat pumps. Refer to Division 23 Section, *Vibration Control for HVAC, Plumbing and Fire Protection Equipment* for specifications.

B. Pressure relief valves shall be provided in the number and sizes required to relieve 110 percent of the full input to the systems. Valves shall be rated; and installed in accordance with ASME, and CSD-1 including all amendments. Pipe discharge full size to floor drain, (with union) and support discharge pipe to prevent exerting any strain on relief valve body, piping to be Type-L copper. Water safety relief valves shall be Watts Series 740, Conbraco, Series 154A, Bell and Gossett, or approved equal. Provide pressure gauge adjacent to all safety relief valves.

2.10. ESCUTCHEONS

A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.

B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.11. DIELECTRIC CONNECTIONS:

A. Furnish and install electrically insulated dielectric unions or flanges, as manufactured by EPCO Sales, Inc., at the following locations:

1. Where steel piping systems join copper piping.
2. Where copper tube connects to domestic water storage tanks, water heaters, heat exchangers, expansion tanks, and other steel vessels.
3. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.

2.12. SLEEVES

A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.

B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend ¾-inch above the floor. Refer to Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment* for mechanical equipment room penetrations additional requirements. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.

C. Sleeves through walls and floors shall be sealed with graphite packing and molten lead and sealed with a waterproof caulking compound.

D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.13. PRESSURE REDUCING VALVES

A. Provide pressure reducing valves as indicated, of size and capacity selected by the installer to maintain operating pressure on the system. Body shall be cast-iron or bronze construction, renewable stainless steel seat, non-corrosive disc, water tight cage assembly, adjustable pressure ranges and inlet strainer Watts Regulator Model 223-S, Armstrong, Bell and Gossett or as approved equal.

B. Provide pressure gauge adjacent to all pressure reducing valves to verify proper set point.

2.14. WATER PROOF PIPE PENETRATION SEALS

A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below

grade or through exterior wall.

B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from –40 degrees F to 250 degrees F.

2.15. TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a). Charlotte Pipe and Foundry Company.
b). Harvel Plastics, Inc.
c). Spears Manufacturing Company.

2. Description: PVC or CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.

D. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a). Colonial Engineering, Inc.
b). NIBCO INC.
c). Spears Manufacturing Company.

2. Description: PVC or CPVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

PART 3. EXECUTION

3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.

B. All piping shall be graded to convey entrained air to high points where automatic air vents shall be provided. The size of supply and return pipes for each piece of equipment shall in no case be smaller than the outlets in the equipment.

C. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common elevations.

D. All valves, strainers, caps, and other fittings shall be readily accessible.

E. Rough-in and final connections are required to all equipment and fixtures provided under this Contract.

F. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.

G. Discharge lines from all relief valves shall be piped to within 4-inches of floor and extend to floor drains wherever floors are not pitched to drains. Pitch the relief valve piping away from the relief valve to issue that no fluid can be trapped in valve discharge. Support all relief valve piping to prevent exerting strain on the relief valve body. The end of the relief valve discharge piping shall not be threaded to prevent capping or plugging.

H. All branches from water mains shall be taken from the top of the supply mains at an angle of forty-five (45) degrees above the horizontal, unless otherwise directed. Branches feeding down shall be taken from the side or bottom of the main on water mains only. All connections shall be carefully made to insure unrestricted circulation, eliminate air pockets or trapped condensate, and permit the complete drainage of the system.

I. Cutoff valves shall be provided on each branch line from the mains on all plumbing lines.

J. Shut-off valves shall be installed at the inlet and outlet of each piece of equipment to permit isolation for maintenance and repair.

K. Balancing valves shall be installed in all domestic re-circulating systems and at all pumps, and where indicated on the drawings.

L. Unions shall be installed on all bypasses, at all connections to equipment, where shown on drawings or where required to facilitate removal of equipment whether shown or not.

M. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.

N. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.

O. Install all valves with stem upright or horizontal, not inverted.

P. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.

Q. Provide clearance for installation of insulation and access to valves and fittings.

R. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

S. All water containing pipes shall be routed clear of fresh air dampers and louvers to prevent freezing condition when dampers are open.

T. Provide manual air vents at top of piping systems

3.2. THERMOMETER AND PRESSURE GAGE INSTALLATION REQUIREMENTS.

A. Install thermometers and adjust vertical and tilted positions.

B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to one-third diameter of pipe.
2. Fill sockets with oil or graphite and secure caps.

C. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.

D. Adjust faces of thermometer and gages to proper angle for best visibility.

E. Clean windows of thermometer and gages and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.3. VALVE INSTALLATION REQUIREMENTS

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

G. Install valves as indicated, according to manufacturer's written instructions.

H. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

I. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

J. Locate valves for easy access and provide separate support where necessary.

K. Install valves in horizontal piping with stem at or above the center of the pipe.

L. Install valves in a position to allow full stem movement.

M. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

3.4. WASTE AND VENT PIPING INSTALLATION REQUIREMENTS

A. Each pipe shall be laid true to line and grade and in such manner as to form a close concentric joint with the adjoining pipe and to prevent sudden offsets of the flow line. All pipe when laid shall rest on the full length of the barrel and bell holes shall be dug in trench

bottoms to make joints. Pipe shall not be adjusted to grade by use of block or wedges. Where rock or old foundations are encountered, trenches shall be excavated 6-inches below grade and crusher run limestone shall be used as a bedding material to support barrel of pipe.

B. As the work progresses, the interior of the sewer shall be cleared of all dirt and superfluous materials of every description.

C. Trenches shall be kept free from water until the pipe jointing material has set and pipe shall not be laid when the conditions of the trench or the weather is unsuitable for such work. At all times, when work is not in progress, all open ends of pipe and fittings shall be securely closed to the satisfaction of the Engineer, so that no trench water, earth or other substance will enter the pipe or fittings.

D. Slip joints will be permitted only in trap seals or on the inlet side of the trap. Unions on the sewer side of the trap shall be ground faced, and shall not be concealed or enclosed. Install bell and spigot pipe with bell end upstream.

E. Threaded joints shall be American Standard taper screw threads with permacel joint compound applied to the male thread. Connections between threaded pipe and cast iron pipe shall have a ring or half coupling screwed on to form a spigot end on the threaded pipe.

F. Establish invert elevations, slopes for drainage to 1/8 inch per foot. Maintain gradients.

3.5. PIPE JOINTS INSTALLATION REQUIREMENTS

A. Welded Joints: Joints in piping 2-1/2-inches and larger shall be fusion welded. Welding shall be in accordance with recommendations of the American Welding Society. Welding fittings shall conform in physical and chemical properties to the latest revisions of the American Society for Testing Materials.

B. Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB). Submit welders qualifications for approval.

C. Screwed Joints: All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.

D. Soldered Joints and Copper Piping: Joints in copper piping shall conform to the following minimum standards.

1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.

3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
5. Solder joints shall be made by using a direct flame from a torch.
6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.

E. Where copper piping joins steel piping, approved bronze adapters shall be used.

F. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

G. Mechanical specification for mechanical joint for cast iron pressure pipe & fittings, ANSI A21.11.

H. Plastic piping solvent cement joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:

1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements. Apply primer.
2. PVC Piping: Join according to ASTM D2855.

3.6. HANGERS AND SUPPORTS INSTALLATION REQUIREMENTS

A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Provide protection saddles between hangers and insulation on heating water insulated pipe. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal.

B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.

C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.

D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.

E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.

F. Select hangers and components for loads imposed. Secure rods with double nuts.

G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.

H. Support overhead piping with clevis hangers.

I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.

J. Refer to structural documents for appropriate connection/attachment materials to building.

3.7. AIR VENTING INSTALLATION

A. The top of each plumbing piping system and other points as indicated or where necessary for the removal of air from the system or equipment, shall be vented using an approved type of manual air vent.

B. In addition to manual air vents at high points of system, each item of water heat transfer equipment shall be manually vented using an approved type manual air vent. All air vents shall be accessible.

3.8. EXPANSION LOOPS AND SWING CONNECTION INSTALLATION REQUIREMENTS

A. Install expansion fittings according to manufacturer's written instructions.

B. Install expansion fittings in sizes matching pipe size in which they are installed.

C. Align expansion fittings to avoid end-loading and torsional stress.

D. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

E. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

F. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

G. Connect risers and branch connections to plumbing equipment with at least four pipe fittings, including tee in riser.

H. Connect mains and branch connections to plumbing equipment with at least four pipe fittings, including tee in main.

3.9. PIPING IDENTIFICATION INSTALLATION

A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.

B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.10. VALVE IDENTIFICATION

A. All valves shall be tagged with a numbered tag.

B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.

C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size, manufacturer and service.

D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in each mechanical equipment room including each air handling unit mechanical equipment room. Additional copies shall be provided in each copy of the O&M manuals.

3.11. CLEANING PIPING AND EQUIPMENT

A. All water plumbing piping, and pumped condensate systems shall be cleaned by filling with a solution of one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water purged of all air.

B. All water, plumbing, and pumped condensate, piping system shall be flushed clean with fresh water. See Division 22 Sections, *Plumbing Fixture* and *Plumbing Equipment* for domestic potable water cleaning and sterilization.

END OF SECTION

DIVISION 22 SECTION 220600
THERMAL SOLAR GRAVITY DRAINBACK SYSTEM
TABLE OF CONTENTS

SECTION 220600 - THERMAL SOLAR GRAVITY DRAINBACK 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes: Liquid-type, medium-temperature, glazed, gravity drainback, domestic hot water, flat-plate, solar collectors, accessories, tanks, pump, controllers, sensors, and mountings.

1.3 DEFINITIONS

A. FSEC: Florida Solar Energy Center.

B. SRCC: Solar Rating and Certification Corporation.

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 solar collectors.
2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

B. Shop Drawings: For solar collectors, tanks, controller, sensors, pumps, meters, mixing valve, and accessories.

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.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of solar collector, certifying compliance with SRCC OG-100.

B. Sample Warranty: For manufacturer's special warranty.

1.6 QUALITY ASSURANCE

A. Collector Certification: Certified by FSEC and SRCC.

B. Manufacturer and collector model shall be listed in "Directory of SRCC Certified Solar Collector Ratings."

1.7 WARRANTY

A.

B. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace solar collectors that fail in materials or workmanship within specified warranty period.

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

1.8 ALTERNATES

A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

PART 2 PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Hail Resistance: Able to withstand 1-inch- (25-mm-) diameter hail.

2.2 COLLECTORS

A. Manufacturers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Solene or comparable product by one of the following:
2. Alternate Energy Technologies, LLC.
3. Bubbling Springs Solar, Inc.
4. Heliodyne, Inc.
5. Hydronic Specialties Co.
6. Integrated Solar, LLC.
7. Oventrop Corporation.
8. Solar Skies Mfg, LLC.
9. Sun Earth Inc.
10. Thermo Dynamics Ltd.
11. Viessmann Manufacturing Company Inc.

B. Enclosure: Extruded aluminum.

1. Finish: Clear anodized, Anodized bronze, or Powder coated.

C. Back Sheet: Aluminum sheet.

D. Insulation: Polyurethane.

1. Minimum Thermal Resistance (R-value): R-7.5 on the back and R-5 on the sidewalls.

E. Absorber Plate: Copper fins and tubes.

F. Absorber Tubes: Copper, NPS 3/4 (DN 65).

G. Header Tubes: Copper 1 inch

H. Type: Gravity Drainback

I. Glazing:

1. Glazing Materials: Single-sheet, low-iron, tempered glass with textured finish on outside surface.
2. Gaskets and Grommets: UV-resistant EPDM gaskets with molded corners and extruded silicone grommets.
3. Continuous secondary silicone seal between the glass and enclosure.

J. Mounting Frame:

1. Fabricated to withstand wind loads of up to 130 mph (210 km/h) with no separation of the collector from the frame or the frame from the structure.

2. Material: Stainless steel or Extruded aluminum.
3. Profile: High angle, 27 to 62 degrees.
4. Fasteners: Stainless steel.

K. Collector Certification: Certified by FSEC and SRCC.

2.3 CONTROLS

A. Manufacturers standard differential controller with power cord, pump power supply, digital read out, tank temperature sensor/cables and solar collector temperature sensor/cable.

2.4 COLLECTOR STORAGE TANK

A. Provide and install solar storage tank for use in a gravity drainback system of the size, dimensions, and capacity as indicated on the Contract Drawings. Storage tank shall be constructed of porcelain enamel lined titanium steel and manufactured by solar heat exchange manufacturing.

B. Tank maximum working temperature shall be 200 degrees Fahrenheit.

C. Tank maximum working pressure shall be 100 psig.

D. Tank insulation shall be minimum 2 inches of polyurethane.

E. Tank shall include the following factory provided components:

1. Magneseum anode.
2. Solar collector inlet/outlet openings.
3. Pressure/temperature relief valve.
4. Domestic water inlet/outlet openings.
5. Two (2) integral temperature sensor well near bottom of the tank.
6. Spirally augmented copper coil heat exchanger.
7. Wilo pump suitable for expected lift/friction.
8. SHEM 32 differential controller.
9. Blue/white flow meters. Located to also act as a site glass.
10. Brass drain valve.
11. Pump flange.

F. Install tank on 18 inch high support stand. Support stand shall be constructed of painted steel angle iron.

1. Solar circuit pump shall continue operation until the differential temperature between tank and solar collectors drops to 4 degrees Fahrenheit (adjustable).

G. Furnish tank with 6 year warranty.

2.5 SOLAR HOT WATER SYSTEM DIFFERENTIAL CONTROLLER

A. Provide and install a shem solar hot water system differential controller.

B. Solar hot water system differential controller shall include the following features:

1. High quality/component design.
2. Mounting holes
3. Up to three sensor inputs and two outputs.
4. Pre-programmed for gravity drainback systems.
5. LCD display.
6. Low temperature protection control.
7. Emergency turn-off temperature control.
8. Tank high limit control.
9. Power cord to control pump.

C. The sequence of operation shall be as follows: (Dual tank/Dual pump)

1. When the solar storage tank temperature is 14 degrees Fahrenheit (adjustable) below the solar collection temperature sensor than the controller shall energize solar circuit pump.
2. Solar circuit pump shall continue operation until the differential temperature between tank and solar collectors drops to 4 degrees Fahrenheit (adjustable).
3. The circulator pump between the solar storage tank and the water heater tank shall be energized when the water heater tank temperature drops to 4 degrees Fahrenheit below the solar storage tank temperature.
4. When the water heater tank temperature reaches the temperature of the solar storage tank then the circulator between the solar storage tank and the water heater tank shall de-energize.
5. The solar storage tank temperature sensor shall de-energize the solar circuit pump when the solar storage tank temperature reaches a maximum temperature of 170 degrees Fahrenheit (adjustable).
6. For freeze protection, regardless of differential temperature between solar collectors and collector storage tank, the solar pump shall not be enabled to operate until the solar collector temperature is at 55 degrees Fahrenheit or above.

D. Warranty: 2 years.

2.6 PUMP FLOW METERS

A. Pump flow meters shall be a blue white F-450 series or approved equal adjustable flow meter.

B. Meter body shall be polysulfane.

C. Float and guide rod shall be 316 stainless steel.

D. O-rings shall be Viton.

E. Maximum temperature rating: 212 degrees Fahrenheit

F. Maximum pressure rating 175 psig.

G. Accuracy: ± 4% of full scale rating.

H. Warranty: 24 months.

I. Furnish and install at solar pump discharge and transfer pump suction. Unit on solar lift pump discharge shall be mounted so the same acts as a site glass also.

J. Range: 0 to 5 gpm.

2.7 SOLAR PUMP

A. Provide and install a high temperature wet rotor circulator as manufactured by Wilo.

B. Pump shall include outlet/inlet flanges with gaskets.

C. Pump shall be self lubricating, cast-iron body.

D. Pump shall be suitable for fluid temperatures up to 230 degrees Fahrenheit.

E. Furnish with three (3) speed tap motor.

F. Motor insulation class F

G. Warranty: 24 months.

2.8 SOLAR TRANSFER PUMP

A. Provide and install a high temperature, automatically lubricated and cooled ecocirc pump as manufactured by Bell & Gossett.

B. Pump shall include outlet/inlet flanges with gaskets.

C. Pump shall be self lubricating, lead free brass body with 316 stainless steel wetted parts.

D. Pump shall be suitable for fluid temperature up to 203 degrees Fahrenheit.

E. Motor shall be permanent magnet ECM type with shaftless spherical bearing and built-in overload protection.

F. Furnish with integral speed switch for field balancing.

G. Warranty 24 months.

2.9 COLD WATER METER

A. Furnish and install a positive displacement cold water meter on the domestic cold water pipe feeding the solar storage tank.

B. Capacity shall be as scheduled on the Contract Drawings.

C. Cold water meter shall be a model RCDL M35 as manufactured by Badger Meter or approved equal bronze disc meter.

D. Direct magnetic drive utilizing high strength magnets. Meter shall measure flow utilizing a nutating disc.

E. Sealed Register: Odometer-type totalization display, 360 degree test circle with center sweep hand and flow finder to detect leaks. Self lubricating thermoplastic gears.

F. The meter shall be provided with an analog flow transmitter for interface with automatic temperature control system. Unit shall be capable of:

1. Operating Temperature: -40°F to 185°F
2. Analog Output: Maximum voltage 10-36 vol supply, current 4-20ma
3. Accuracy: within 0.5% of point unit shall be constructed of bronze (N6MA 4X) with a two wire (signal/power) circuit interface with reversed polarity protection output. The analog flow transmitter shall be model FT420B as manufactured by Badger Meter or approved equal.

G. Warranty: 24 months.

2.10 HIGH/LOW MIXING VALVES WITH CABINET

A. Furnish and install high/low thermostatic controller valves of the size, capacity and arrangement as scheduled on the contract drawings. Units shall be pre-piped and installed within a surface mounted cabinet.

B. Each unit shall consist of two (2) thermostatic controllers with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid fill thermal motor with bellows element mounted out of water, inlet manifold piping, pressure reducing valve (PRV), two (2) pressure gauges, two (2) ball valves, bi-metal dial thermometer (3-inch face, range 201 – 240 degrees F), wall bracket, connecting piping and fittings to cabinet limit.

C. All equipment and piping shall be finished in rough bronze and/or copper. Bottom supplies and top outlet. Field insulate all piping within the cabinet as specified in Division 22 Section, *Plumbing Insulation*.

D. Cabinet shall be surface mounted with 16 gauges body, white baked enamel finish, 12 gauge left hinged door with cylinder lock and key.

E. Complete unit shall be factory assembled and tested. Field insulate all piping within enclosure.

F. High/low mixing valves shall be Symmons, Lawler, Powers, or approved equal.

G. High/low mixing valves must be piped per the manufacturer's recommendations.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions for compliance with requirements for installation and other conditions affecting performance of the Work.

B. Examine roughing-in for solar-collector piping to verify actual locations of piping connections before solar-panel installation.

C. Examine walls and roofs for suitable conditions where solar collector will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SOLAR SYSTEM INSTALLATION

A. Comply with manufacturer's written instructions for collector mounting tank mounting and installation.

B. All exterior hardware shall be stainless steel.

C. Install the collector according to ASHRAE's "Active Solar Heating Systems Installation Manual."

D. Install pipe curbs and flashing.

E. Slope all piping and solar collectors ¼ inch per foot back toward the storage tank.

F. Install low-voltage wiring from the sensor to the energy-management panel. Sensor wings shall be minimum 18 gauge.

G. Mount the collector frame support feet to the structural support steel using stainless-steel bolts. Attach each pair of legs using two bolts for each. Seal all roof penetrations with polyurethane sealant.

H. Place high-temperature-resistant covers over the header to prevent contaminants from entering the headers.

I. Install solar storage tank on minimum 18 inch high painted steel stand.

J. Coat the controller's sensor with a layer of thermal paste and insert into the collector sensor port to full depth. Apply a silicone sealant around the entire perimeter of the sensor where it enters the collector. Completely cover the opening with insulation to prevent water ingress. Only use high-temperature-rated (minimum 395 deg F (202 deg C)) sensors and cabling. Utilize stainless steel pipe clamp at exterior temperature sensor.

K. After connecting the inlet and outlet of the collectors to the system, test all piping and collectors for leaks.

L. Install collectors with not less than minimum space for access and service as recommended by solar-collector manufacturer.

M. Insulate and jacket all solar collector piping as specified in Division 22 Section, “Plumbing Insulation”.

N. Drain off manufacturer’s required volume of water from tank to act as expansion chamber.

3.3 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Section "Plumbing, Piping, Fittings, and Valves." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install water meter in cold water piping with heat trap. Install water meter in horizontal position not vertical position.

C. Where installing piping adjacent to solar collectors, allow space for service and maintenance.

D. Install flexible connections on piping between collectors installed in series.

E. Install union at inlet and outlet of solar collectors and tank. Comply with requirements in Division 22 Section "Plumbing, Piping, Fittings, and Valves" for materials and installation requirements for unions.

F. Connect solar collectors to lightning protection system. Comply with requirements in Division 26 Section "Lightning Protection."

G. Install pressure/temperature relief valve with union on discharge. Pipe to closest floor drain.

H. Install unions at all tank connections and all solar collector connections.

I. Fill storage tank with water prior to filling the storage tank heat exchanger to provide buoyancy around heat exchanger.

J. Provide 3-valve bypass around back-up water heating system.

K. Install thermometers at all solar and domestic water connections to the storage tank.

L. Comply with requirements for insulation specified in Division 22 Section “Plumbing Insulation”.

M. Furnish and install all sensors, equipment, and devices indicated for mounting by the ATC system.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify tilt angle, pipe slope, collection slope, mounting, fluid concentrations, and collector array arrangement.

3.5 ADJUSTING

A. Adjust tilt angle per design requirement and adjust the collector balance valve to provide the design flow.

B. Adjust slope of collectors and all solar supply/return piping. Slope collectors and solar supply/return piping toward the solar return pipe at ¼ inch per foot minimum.

END OF SECTION

DIVISION 22 SECTION 220701
PLUMBING INSULATION

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SECTION 220701 - PLUMBING INSULATION

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. REFERENCE

A. The Conditions of the Contract and other General Requirements apply to the work specified in this Section. All work under this Section shall be subject to the requirements of Division 22 Section, *Common Work Results for Plumbing*.

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

1.3. DESCRIPTION

A. All piping and equipment installed under this Contract shall be covered as specified.

1.4. SCOPE

A. The work covered by this specification 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 all piping, equipment, and systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

1.5. STANDARDS

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 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation".
b). ASTM C 533, "Standard Specification for Calcium Silicate Pipe & Block Insulation".
c). ASTM C 55, "Standard Specification for Mineral Fiber Blanket and Felt Insulation".
d). ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)".
e). ASTM C 612, "Standard Specification for Mineral Fiber Block and Board Thermal Insulation".
f). ASTM C 1136, "Standard Specification for Barrier Material, Vapor, "Type 1 or 2 (Jacket only).
g). ASHRAE 90.1 "Energy efficient design of new buildings except low-rise residential buildings", latest edition.

B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.6. 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) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, (latest edition) and "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), latest edition. 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. As minimum, all insulation thicknesses shall be as hereinafter specified.

B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:

1.	American Society for Testing of Materials	ASTM E 84
2.	Underwriters' Laboratories, Inc.	UL 723
3.	National Fire Protection Association	NFPA 255

C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos-free characteristics.

1.7. 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.

C. Mockups:

Provide at project site a sample of each type of insulation hereinafter specified. Display insulation in an "installed" condition, showing typical completed pipe, covers, fittings, ductwork and equipment insulation. No insulation shall be applied until these samples have been accepted by the Engineer. Any insulation work which does not conform to the accepted samples will not be acceptable, and shall be removed and re-installed in a manner acceptable to the Engineer at no additional cost to the Owner. Build mockups according to the following requirements, using materials indicated for the completed work.

1. Include the following pipe insulation mockups:

    a). Exterior aluminum jacketing
    b). One 10-foot section of NPS 2 inch straight pipe.
    c). One 90-degree elbow.
    d). One tee fitting.
    e). One NPS 2 inch valve.
    f). Four support hangers, including hanger shield and insert.
    g). One strainer with removable portion of insulation.
    h). One reducer.

2. Include the following equipment insulation mockups:

    a). One backflow preventer.
    b). One small tank or vessel.
    c). One plumbing pump/circulator.

3. Mockups shall include samples of both concealed insulation and exposed insulation.
4. Build mockups with cutaway sections to allow observation of application details for insulation materials, mastics, attachments, and jackets.
5. Build mockups in the location indicated or, if not indicated, as directed by Engineer.
6. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
7. Obtain Engineer approval of mockups before starting insulation application.
8. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
9. Demolish and remove mockups when directed.
10. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.8. 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 in writing for technical assistance.

D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements. Protect all insulation from water, construction traffic, dirt, chemical and mechanical damage.

1.9. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. GENERAL

A. All materials to be insulated shall be thoroughly cleaned, after completion of successful tests, and shall be covered as specified below. Fiberglass insulation shall be Owens-Corning, Manville, Armstrong, or P.P.G, or as approved equal.

2.2. PIPE INSULATION MATERIALS

A. Unless otherwise noted, insulation shall be one piece or half sectional molded fibrous glass with “K” rating of .23 at 75 degrees F mean temperature, for service temperatures between -60 degrees F and +450 degrees F with all service jacket. Pipe insulation shall be fiberglass SSL II with double closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.

B. Solar collector supply/return pipe insulation – Furnish and install Armaflex HT or approved equal, flexible, high temperature, U.V. resistant insulation. Seal all pipe insulation with Armaflex HT 625 adhesive. Insulation shall have the following properties:

1. Thermal conductivity (K-value) = .30 BTU inch/Hr per square foot per degree Fahrenheit.
2. Water vapor permeability = .05 perm – inch
3. Max water absorption = .2%
4. Density = 5 lbs per cubic foot
5. Ozone Resistance = Excellent
6. Upper use limit = 300 degrees Fahrenheit
7. Lower use limit = -20 degrees Fahrenheit

C. Install aluminum jacketing over all solar piping and solar collector header ends. Paint to match adjacent roof color.

D. Unless otherwise noted, pipe insulation jacket shall be factory-applied vinyl coated, embossed and reinforced vapor barrier laminate, with a perm rating of not more than 0.02 perms. All hot and cold, concealed and exposed butt strips shall be of the same material as the jacket. Jacket and butt strips shall be sealed with field-applied Benjamin Foster adhesive. Jacket and butt strips shall be off-white color and shall be equivalent to Owens-Corning Fiberglass 25-ASJ.

E. For fittings on all piping, valves and flanges, apply fiberglass molded or segmented insulation equal in thickness to the adjoining insulation and securely fasten in place using wire. Apply a skin coat of insulating cement to produce a smooth surface. After cement is dry, apply a light coat of fitting mastic, UL labeled, Type C, for cold water piping, and Type H for hot water piping. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of Type C or Type H mastic over the reinforcing cloth, working it to a smooth finish. As an option to the above fittings, a polyvinyl chloride fitting cover may be supplied.

F. All pipe insulation, jackets, or facings, and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 225, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Accessories such as adhesives, mastic cements, tapes and cloth for fittings shall have the same ratings as listed above. All products or their shipping cartons shall bear the Underwriter's label indicating that flame and smoke ratings do not exceed the above criteria.

G. For piping having a vapor barrier insulation and for all insulated piping requiring supports, hangers and supports shall be installed outside the insulation. Wherever hangers and supports are installed outside the insulation, pipe insulation protecting shields shall be provided. Where insulation is a load bearing material, of sufficient strength to support the weight of the piping, pipe shields one-third the circumference of the insulation and of a length not less than three times the diameter of the insulation (maximum length 24-inches) shall be provided. Insulation of 7-1/4 pound or greater density will be considered as load bearing for pipe sizes up to and including 2-inches. Where insulation is not of sufficient strength to support the weight of the piping, a half section of high density fiberglass or foam

inserts, shall be provided. Vapor barrier and finish shall be applied as required to match adjoining insulation. In addition, shields shall be furnished as specified above.

H. For piping located outside of the building, an corrugated aluminum weatherproof jacketing system shall be provided. This system shall be Micro-Lot ML as manufactured by Manville, Polyweld by Pabco Metals Corp., Childers, or as approved equal, and installed per the manufacturer's recommendations. Where outdoor piping is receiving electric heat tape, the insulation shall be oversized so that the heat tape is not compressed tightly to the pipe. Pipe jacketing shall be corrugated (3/16-inch) deep aluminum, .016-inch thickness of H-14 temper with aluminum strapping of .75-inch width and .020 inch thickness with moisture barrier. Aluminum jacketing elbows shall be smooth, .016-inch thickness and 1100 alloy. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation. Longitudinal joints shall be applied so they will shed water and shall be sealed completely. Circumferential joints shall be closed using preformed butt strips following manufacturer's recommendations for securement. Jacket seams shall be located on the bottom side of the horizontal piping.

I. On cold systems such as domestic cold water, rainleaders, vapor barrier performance is extremely important. All penetrations of the ASJ and exposed ends of insulation must be sealed with vapor barrier mastic. The ASJ must be protected with either a mastic coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

J. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of Fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings. Where applicable, Victaulic PVC fitting valve and coupling covers shall be utilized. Victaulic PVC covers shall be installed with matching pipe insulation jacketing material, vinyl tape, solvent weld adhesive and appropriate fasteners.

1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor-resistant mastic as dictated by the system location and service. Finish valve installation with a Tyvac jacket with ends that secure to adjacent piping.
2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion. All gauge and thermometer penetrations and extensions shall be correctly sealed and insulated to prevent surface condensation.

K. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger.

On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.

1. Piping systems 3-inches (7.5cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation. Hangers saddles shall be minimum 16 gauge with a saddle arc of 120 degrees minimum.
2. For hot or cold piping systems larger than 3-inches (7.5 cm) in diameter, operating at temperatures less than +200 degrees F (93 degrees C) and insulated with fiber glass, high density inserts such as foam with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding ±200 degrees F (93 degrees C), Owens-Corning Pink Calcium Silicate pipe insulation shall be used for high density inserts.
3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7kg/cm).
4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
5. Thermal expansion and contraction of the piping and insulation system shall generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.
6. On vertical runs, insulation support rings shall be used.

2.3. PIPING INSULATION THICKNESSES SCHEDULE

A. All piping shall be insulated with pipe insulation of the thicknesses indicted below:

PIPING INSULATION THICKNESS SCHEDULE SERVICES	**THICKNESS**
All Horizontal Roof Drain Piping Including Sumps	1-inch thickness
All Drain Piping from Cooling Coils/Evaporators	½-inch thickness
All Domestic Hot and Cold Water Piping , including Re-circulating Piping	1-inch thickness
Auxiliary Drain Pipes from Auxiliary Pans	1-inch thickness
Above Grade Trap Priming Lines	½ -inch thickness
Electric Water Cooler Drains	1-inch thickness
Domestic Water Pre-Heat Water Piping	1-inch thickness
Domestic Pre-Heat Water	1-inch thickness

PIPING INSULATION THICKNESS SCHEDULE SERVICES	**THICKNESS**
Solar Collector Supply/Return Piping	1-inch thickness
Tempered Water Piping Serving Emergency Fixtures	1-inch thickness

2.4. EQUIPMENT INSULATION MATERIALS AND THICKNESSES

A. The following equipment shall be insulated with Fiberglass Rigid Board Insulation or Foam Plastic Insulation:

1. Expansion Tanks.
2. Chemical Feed Tanks.
3. Domestic Water Meters.
4. Backflow Preventer Valve Bodies.
5. Plumbing Pumps.
6. All Pump Volutes and Strainers.
7. All piping within emergency and high-low mixing valve cabinets.

B. Insulation for cold surfaces shall be 1-1/2-inch thickness, 6 lb. density, 705 FRK with a "K" rating of .23 at 75 degrees F mean temperature. Insulation for hot surfaces except as otherwise noted shall be 1-1/2-inch thickness, 6 lb. density, 705 with a "K" rating of .23 at 75 degrees F mean temperature. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be 1-inch by 25 gauge galvanized steel spaced on not over 12-inch centers. All joints and voids shall be filled with Owens-Corning #110 cement, well troweled into openings. For 705 FRK insulation, all joints and voids shall be FRK taped and vapor sealed. There shall be applied over the insulation surface 1-inch 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 2-inch thick layer of Owens-Corning #110 cement applied in two layers. Install metal corner beads at all corners and edges in order to provide a permanent installation. Onto the dry cement surface apply a brush coat of Foster Sealfas 30-36 at the rate of 60-70 square feet per gallon. Embed into wet coating a layer of 8 ounce canvas 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. Cleanouts, nameplates, and manholes shall not be insulated, and the insulation on surrounding surfaces shall be neatly beveled off at such openings.

C. Insulation installation on pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from aluminum at least 0.040 inch (1.0 mm) thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

D. Mechanical fasteners shall be utilized to hold insulation to surface with bands as required to hold the curvature of the material.

E. Support rings shall be provided to support the top head insulation where required.

F. Outdoor installations require a weather barrier for protection of the insulation jacketing.

G. Insulation types materials shall be suitable for temperatures encountered by each item of equipment.

2.5. ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under this section shall include, but not be limited to:

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
2. Field-applied jacketing materials - sheet metal, plastic, canvas, fiber glass cloth, insulating cement; PVC fitting covers, PVC jacketing.
3. Support Materials - Hanger straps, hanger rods, saddles.
4. Fasteners, weld pins/studs, speed clips, insulation washers.
5. Metal mesh or expanded metal lagging.

B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Insulation Standards."

2.6. FIELD-APPLIED JACKET (ALTERNATE)

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a). Johns Manville; Zeston.
b). P.I.C. Plastics, Inc.; FG Series.
c). Proto PVC Corporation; LoSmoke.
d). Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color coded per system.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

    a). Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

PART 3. EXECUTION

3.1. WORKMANSHIP

A. The Contractor shall take special care to prevent soiling equipment below or adjacent to areas being insulated. He shall be completely responsible for removing insulation cement splashes and smears and all surfaces that he mars or otherwise soils or defaces, and he will be totally responsible for restoring these damaged surfaces to their like-new condition when delivered to the site.

3.2. SITE INSPECTION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.3. PREPARATION

A. Ensure that all pipe and equipment surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping or duct systems has been completed prior to installing insulation.

3.4. INSTALLATION

A. Piping Systems

1. General:

a). Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
b). Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.
c). Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
d). Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tear or other damage. Seal all tears, punctures and other penetrations of the pipe insulation vapor barrier facing.
e). On exposed piping, locate insulation and cover seams in least visible location.

2. Fittings: Cover valves, fittings, unions, flanges, strainers, flexible connections, expansion joints, pump bodies, strainers, blowdowns, backflow preventers, autoflow valves and similar items in each piping system using one of the following:

a). Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.
b). Insulation cement equal in thickness to the adjoining insulation.
c). PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.

3. Penetrations: Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.
4. Joints:

a). Butt pipe insulation against hanger inserts. For hot pipes, apply 3-inch (7.5cm) wide vapor barrier tape or bank over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3-inch (7.5cm) wide vapor barrier tape or band.
b). All pipe insulation ends shall be tapered and sealed, regardless of service.

B. Equipment Insulation:

1. General:

a). Install insulation in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.

b). Install insulation on equipment after installation of heat tracing, painting, testing, and acceptance tests.

c). Install insulation materials with smooth, even surfaces. Rework poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply insulation using staggered joint method for both single and double layer installation, applying each layer of insulation separately.

d). Coat insulated surfaces where specified on contract drawings with layer of insulating cement, troweled in a workmanlike manner, leaving a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.

e). Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. Seal all tears, punctures and other penetrations of equipment insulation facing.

f). Where specification calls for field-applied all-service vapor barrier jacketing, it shall be neatly fitted and tightly secured. Lap seams 2-inches (5cm) (min.). Seal all joints with adhesive. Tape with 3-inches (7.5cm) matching pressure-sensitive tape or 3-inch (7.5cm) glass fabric and mastic.

g). On exposed equipment, locate insulation and cover seams in least visible location.

2. Removable Insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, such as vessel covers, fasteners, flanges, frames accessories, manholes, handholes, cleanouts ASME stamp, and manufacturer nameplates.

3. Areas Left Uninsulated: Items such as manholes, handholes, clean-outs, ASME stamp, and manufacturers' nameplates should be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, provide removable insulation and appropriate tagging to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

4. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather barrier mastic protective finish or jacketing as recommended by the jacketing manufacturer.

3.5. FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.6. PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.7. SAFETY PRECAUTIONS

A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.8. INSULATION COVERING (ALTERNATE)

A. Unless otherwise noted, all exposed equipment insulation shall have a field applied PVC jacket cover neatly cut and pasted over equipment insulation. PVC shall be color coded by system and shall be 30 mils thick. Exposed areas include, but are not limited to, all mechanical equipment rooms/fan rooms, electric rooms, and piping and ductwork exposed in an occupied space.

B. Unless otherwise noted, all exposed pipe insulation required to be insulated shall be jacketed with a PVC Jacketing with fitting covers. PVC jacket shall be color fade resistant, color coded, U.S.D.A. authorized as manufactured by Proto Corporation or approved equal. PVC jacketing shall be high impact, ultraviolet resistant PVC. Minimum thickness shall be 30 mils, roll stock ready for shop or field cutting and forming. Suggested color coding shall be as follows:

1. Storm Water Piping – Blue
2. Solar Thermal Piping – Orange
3. Domestic Hot, Cold and Recirculating Piping – White

All colors shall be in accordance with ANSI Standards. Submit color coding for review and approval.

C. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints, for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

END OF SECTION

DIVISION 22 SECTION 224000
PLUMBING FIXTURES

TABLE OF CONTENTS

SECTION 224000 - PLUMBING FIXTURES

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. GENERAL

A. For General Mechanical Requirements, see Division 22 Section, *Common Work Results for Plumbing* & Division 01, *General Requirements.*

B. Drawings and general provisions of the Contract, including *General and Supplementary Conditions* and Division 01 specifications apply to this Section.

C. All exposed bolts, screws, etc., shall be vandal proof.

D. All plumbing materials, equipment and fixtures shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.

E. Piping and insulation are specified under other sections.

F. Use "Sani-Sett" setting compound for fixtures.

G. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code and International Plumbing Code, local code, and all other authorities have jurisdiction.

H. Provide stops for all plumbing fixtures and equipment. Stops are to be accessible.

I. Provide P traps on fixtures for which traps have not been included as part of furnished

equipment. Trap size to equal size of fixture tailpiece.

J. All exposed metal parts of fixtures shall be chromium plated brass. Piping, fittings, valves, traps and accessories including escutcheons for piping shall be chromium plated where exposed in finished areas.

K. All faucets for lavatories, commercial sinks, drinking fountains, bubblers, and ice makers shall be listed for drinking-water or commercial applications by the National Sanitation Foundation (NSF) or Underwriters Laboratory (U.L.). All required faucets shall comply with NSF Standard 61 for both lead content and leaching rate. Submit documentation indicating compliance for all required faucets.

L. Ensure products and installation of specified products are in conformance with recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF).
2. American Society of Mechanical Engineers (ASME).
3. National Electrical Manufacturers' Association (NEMA).
4. Underwriters Laboratories (UL).

1.3. REFERENCES

A. ANSI/ASME A112.6.1 - Supports for Off-the-floor Plumbing Fixtures for Public Use.

B. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

C. ANSI/ASME A112.19.1 - Enameled Cast Iron Plumbing Fixtures.

D. ANSI/ASMI A112.19.2 - Vitreous China Plumbing Fixtures.

E. ANSI/ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).

F. ANSI/ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.

G. ANSI/ASME A112.19.5 -Trim for Water-Closet Bowl, Tanks, and Urinals (Dimensional Standards).

H. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

I. ANSI/ARI 1010 - Drinking-Fountains and Self- Contained, Mechanically-Refrigerated Drinking-Water Coolers.

J. ANSI/NFPA 70 - National Electrical Code.

K. IBC - International Building Code

1.4. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01, Section *General Requirements*.

B. Accept fixtures on site in factory packaging. Inspect for damage.

C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.5. FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.

B. Confirm that millwork is constructed with adequate provisions for the installation of counter top lavatories and sinks.

1.6. EXTRA MATERIALS

A. Provide two sets of faucet washers and flush valve service kits to the Owner. Provide correspondence to Engineer that extra materials have been turned over to the Owner.

1.7. GRAB BAR COORDINATION

A. For handicapped plumbing fixtures coordinate location of flush valves with grab bars prior to installation.

1.8. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.9. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2. PRODUCTS

2.1. PLUMBING FIXTURES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Water Closets, Urinals and Lavatories: Kohler, Crane, American Standard, Falcon,

Waterles, Sloan, Zurn.

2. Water Closet Seats: Kohler, Church, Comfort Seats, Bemis.
3. Faucets: Chicago Faucet, Kohler, Speakman, Symmons, T&S Brass, Zurn, Moen
4. Drains: Chicago Faucet, Engineered Brass Co., Kohler, McGuire
5. Stops & Supplies: Chicago Faucet, T&S Brass, McGuire, Brass Craft
6. Flush Valves: Sloan, Delany, Zurn
7. Traps: Kohler, McGuire, Dearborn, Engineered Brass Co. (17 gauge min.)
8. Carriers & Supports: Zurn, Josam, Ancon, J. R. Smith, Mifab
9. Sinks: Elkay, Just, American Standard
10. Mop Sinks: Stern-Williams, Fiat, Acorn
11. Electric Water Coolers/Drinking Fountains: Haws, Elkay, Oasis, Halsey Taylor, Acorn
12. Emergency Fixtures: Bradley, Haws, Speakman, Chicago Faucet
13. Aerators: Bricor, Neoperl

B. P-1

1. Watercloset (Infra-red); (battery powered) (wall hung, flush valve) Kohler Model K-4325 Kingston Water-Guard Toilet, American Standard 3351, vitreous china, elongated bowl design, siphon jet flushing, wall hung with bolt caps, seat, carrier, supplies and stops. Unit and installation shall comply with the American Disabilities Act Guidelines and ANSI A117.1 requirements for people with disabilities.
2. Flushometer: Sloan Model #8111-1.28 Optima Plus, Delany, Zurn, American Standard 6065, or approved equal, low consumption (1.28 GPF), exposed diaphragm type, chrome plated brass, battery powered, sensor operated closet flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for automatic "no hands" operation, courtesy flush override button, "low battery" flashing LED, infrared sensor range adjustment screw, initial set-up range indicator light, four (4) size AA batteries, 1-inch I.P.S screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for 1 ½-inch top spud. Supply with Sloan Model J-212-A, American Standard 6065.862 split ring wall support. Provide 3 year limited Manufacturer's warranty.
3. Seat: Kohler Model K4670-C, American Standard 5901.00 solid plastic white seat with open front and check hinge.
4. Carrier: Zurn, Josam or Ancon cast iron watercloset Carrier with fittings as required. ANSI/ASME A112.6.1 adjustable cast iron frame integral drain hub and vent, adjustable speed, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

C. P-1A

1. Watercloset (Handicapped) (Infra-red); (battery powered) (wall hung, flush valve) Kohler Model K-4325 Kingston Water-Guard Toilet, American Standard 3351, vitreous china, elongated bowl design, siphon jet flushing, wall hung with bolt caps, seat, carrier, supplies and stops.
2. Flushometer: Sloan Model #8111-1.28 Optima Plus, Delany, Zurn, American

Standard 6065, or approved equal, low consumption (1.28 GPF), exposed diaphragm type, chrome plated brass, battery powered, sensor operated closet flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for automatic "no hands" operation, courtesy flush override button, "low battery" flashing LED, infrared sensor range adjustment screw, initial set-up range indicator light, four (4) size AA batteries, 1-inch I.P.S screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for 1 ½ -inch top spud. Supply with Sloan Model J-212-A, American Standard 6065.862, split ring wall support. Provide 3 year limited Manufacturer's warranty.

3. Seat: Kohler Model K4670-C, American Standard 5901.00 solid plastic white seat with open front and check hinge.
4. Carrier: Zurn, Josam or Ancon cast iron watercloset Carrier with fittings as required. ANSI/ASME A112.6.1 adjustable cast iron frame integral drain hub and vent, adjustable speed, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

D. P-2

1. Urinal (Handicapped) (Infra-red); (Battery powered, flush valve) Kohler model K-4904-ET Bardon water guard, American Standard 6501, urinal, vitreous china, washout design, 3/4-inch top spud inlet, 2-inch outlet and carrier. Fixture lip mounted 17-inches above finished floor. Unit and installation shall comply with the American Disabilities Act Guidelines and ANSI A117.1 requirements for people with disabilities.
2. Flushometer: Sloan Model #8186-0.13 Optima Plus, Delany, Zurn, American Standard 6063.101, or approved equal, low consumption (1.0 pint flush), exposed diaphragm type, chrome plated brass, battery powered, sensor operated urinal flushometer. Unit shall include the following features and accessories: ADA compliant battery powered infrared sensor for "no hands" operation, "low battery" flashing LED, infrared sensor range adjustment screw, initial set-up range indicator light, four (4) size AA batteries, ¾ -inch I.P.S. screwdriver back check angle stop, locking vandal resistant stop cap, sweat solder adapter with cover tube and cast set screw wall flange, adjustable tail piece, vacuum breaker flush connection with one piece bottom hex coupling nut, spud coupling and flange for ¾ -inch top spud. Supply with Sloan Model J-212-A split ring wall support. Provide 3 year limited Manufacturer's warranty.
3. Carrier: Zurn, Josam or Ancon cast iron urinal carrier with fittings as required. ANSI/ASME A112.6.1A; cast iron and steel frame with tubular legs, legs for floor and wall attachment, threaded fixtures studs for fixture hanger, bearing studs.

E. P-3

1. Lavatory (Handicapped, Infra-Red) (battery operated) Sloan faucet, Counter Mounted: Kohler Model K-2196, American Standard Aqualyn 0475.047 self rimming counter top lavatory with rear overflow and faucet ledge. Faucet ledge shall be drilled for 4-inch center faucets. outlet. Unit shall be ADA compliant.
2. Faucet: Sloan Faucet No EBF-650 Optima Plus Electronic Faucet, American

Standard 6055.163, polished chrome finish, 5 inch spout, solenoid valve with filter, and vandal resistant remote housing. Unit shall operate on 4 standard "AA" batteries. Furnish unit with batteries. Unit shall include check cartridges, 0.5 GPM flow rate, and mixing "Y". Unit shall be ADA compliant.

3. Thermostatic Mixing Valve: Provide and install below fixture. See Part 2 Products "Thermostatic Mixing Valves".
4. Strainer: Chicago Faucet Model 327A, American Standard 2411.015, with 1 ¼ -inch tailpiece, non removable brass strainer, grid strainer waste, chrome plated finish.
5. P-Trap: Chicago Faucet Model 337, American Standard 7723.018, offset drain assembly.
6. Stops: Chicago Faucet Model 1005 valve stops with 3/8-inch loose key cap and removable tee handle, wall flange, chrome plated finish.
7. Lavatory Protective Enclosure: Provide and install Truebro Model #2018 lav shield lavatory enclosure on all lavatories with sensor operated faucets. Protective enclosure shall be ADA conforming 20-inch x 18-inch wheel chair accessible. Unit shall have white finish, be constructed of high impact, stain resistant vinyl, and include seven (7) wall anchors.

F. P-3A

1. Lavatory (Infra-red) Handicapped: (wall hung) (battery operated) Sloan faucet, Kohler Model K-2032 Greenwich, American Standard Lucerne 0356.421, wall mount lavatory, vitreous china with 20-inch x 18 bowl, and 4-inch faucet centers. Provide concealed arm Carrier.
2. Faucet: Provide sensor operated faucet. Sensor operated faucet shall be Sloan Faucet Model EBF-650 Optima Plus with cast brass spout, forged brass cover plate, solenoid valve with filter, chrome finish and vandal resistant remote housing. Unit shall operate on 3 volts D.C. powered by two (2) alkaline "AA" batteries (included). Unit shall include check cartridges, 0.5 GPM flow rate. Unit shall be ADA compliant.
3. Thermostatic Mixing Valve: Provide and install below fixture. See Part 2 Products, "Thermostatic Mixing Valves" of this section.
4. Lavatory Protective Enclosure: Provide and install Truebro Model # 2018 lav shield lavatory enclosure on all lavatories with sensor operated faucets. Protective enclosure shall be ADA conforming, 20-inch x 18-inch wheel chair accessible. Unit shall have white finish, be constructed of high impact, stain resistant vinyl, and include seven (7) wall anchors.
5. Strainer: Chicago Faucet Model 327A, American Standard 2411.015 with 1 ¼ inch tailpiece, non removable brass strainer, grid strainer waste, chrome plated finish.
6. P-Trap: Chicago Faucet Model 337, American Standard 7723.018 offset drain assembly.
7. Stops: Chicago Faucet Model 1005 valve stops with 3/8-inch loose key cap and removable tee handle, wall flange, chrome plated finish.

G. P-4

1. Mop Sink: (Corner Unit) (32-inch x 32-inch unit) Stern Williams Model SBC-1725 or approved equal, size 32-inch x 32-inch x 12-inch terrazzo unit. Unit shall have 6-inch drop at threshold. Drain shall be cast brass with stainless steel strainer cast integral and shall provide for a caulked lead connection. Receptor composed of

pearl grey marble chips and white Portland unit, ground smooth, grouted, and sealed to resist stains. Stainless steel cap of one piece 20 gauge, 302 stainless steel cast integral on threshold. Provide and install stainless steel BP splash Catcher panels on adjacent walls.

2. Faucets: Chicago faucet 897-RCF, Speakman SC-5811-RCD or approved equal (rough chrome finish) with cast brass, chrome plated body, vacuum breaker spout, stops in arms. Faucet shall include 3/4-inch hose thread outlet, Pail Hook, and wall brace. Provide unit with Stern Williams T-35 hose and bracket and mop hanger.

H. P-5

1. Electric Water Cooler (Dual Height) (Handicapped) Surface Mounted Unit: Haws Model HWBFA8L.VRC, Acorn or approved equal, Barrier-free, dual height unit with mounting frame. Air cooled electric water cooler shall be capable of delivering 8 GPH at 90 degrees F ambient 80 degrees F, inlet water and 50 degrees F outlet drinking water. Top shall be stainless steel; bubblers shall be hooded with anti-squirt angle stream. Cabinet shall be heavy gauge steel with a powder coated covering. Unit shall be supplied with plug-in, 3-wire, grounding type service cord for operation on l20 volt/l phase/60 HZ. Lower spout outlet shall be mounted 36 inches above finished floor. Upper spout outlets shall be mounted 42-inches above finished floor. Water cooler and installation shall conform to all requirements of American Disabilities Act Guidelines and ANSI A117.1.
2. Refrigerant shall be R-134a or equivalent environmentally friendly refrigerant.
3. Provide Carrier as manufactured by Zurn, Josam, Amcon, Smith, Mifab, or approved equal.

I. P-6

1. Counter Sink (Handicapped) (Single Bowl) Elkay Lustertone Model LRAD-1716 single bowl unit. Overall dimensions shall be 17-inch x 16-inch x 5 ½ -inches deep. Unit shall be manufactured of 18 gauge, type 302 stainless steel with fully coated underside. Sink shall be counter mounted complete with 8-inch faucet centers. Self rimming. Unit and installation shall comply with the American Disabilities Act Guidelines and ANSI A117.1 requirements for people with disabilities.
2. Faucets: Chicago Faucet Model 201-AGN8AE3-317CP deck mounted lavatory faucet with GN8A rigid/swing gooseneck spout with E35 Aerator and Model 317 wrist blade handles. Faucets shall be ADA compliant. Faucets shall be 8-inches on center with chrome plated finish. Aerator flow rate shall be 1.5gpm.
3. Strainer: Jomar Model SS-306 Snap-N-Loc basket strainer and brass locknut and tailnut. Deep cup body and basket shall be 300 series stainless steel. Provide 1 ½-inch tailpiece.
4. P-Trap: Cast Brass 1 ½ -inch "P" trap. Unit shall be offset drain assembly with under lavatory insulation.
5. Stops: Chicago Faucets Model 1005 valve stops with riser supply, 3/8-inch loose key cap and removable tee handle, wall flange, chrome plated finish.
6. Insulation: See this Section.

J. P-6A

1. Hand Sink: (Wall Hung, Single Bowl) Elkay Model ELV-2219, 22-inch x 19-inch x

5 ½-inch deep single bowl rectangular wash-up sink. Unit shall be manufactured of #18 gauge, Type 304, stainless steel with fully coated underside. Corners shall be coved with 2 ½ -inch high splash back. All exposed surfaces shall be hand blended to LK-6K satin finish. Unit shall be complete with wall hanger and support brackets. Unit shall comply with American Disabilities Act Guidelines and ANSI A117.1 requirements for people with disabilities.

2. Faucets: Chicago Faucet Model 786-E3-320 deck mounted lavatory faucet with GN2A swing/rigid gooseneck spout with E3 aerator and Model 320 wrist blade handles. Faucets shall be ADA compliant. Faucets shall be 4-inches on center with chrome plated finish. Aerator flow rate shall be 1.5gpm.
3. Strainer: Jomar Model SS-306 snap-n-loc basket strainer and brass locknut and tailnut. Deep cup body and basket shall be 300 series stainless steel. Provide 1 ½ -inch chrome tailpiece.
4. P-Trap: Chrome plated 1- ½ -inch "P" trap.
5. Stops: Chicago Faucets Model 1005 valve stops with riser supply 3/8 loose key cap and removable tee handle, wall flange, chrome plated finish.
6. Insulation: See this Section.

K. P-7

1. Emergency Eyewash/Shower (Handicapped): Bradley Model Sl9-310BF Barrier free eyewash/shower assembly. Provide 10-inch diameter stainless steel eyewash bowl, chrome plated brass spray head assembly, twin soft flow eye wash heads with dust covers. Shower head shall be durable ABS plastic with self closing l-l/4-inch stay open ball valve and pull chain. Unit shall be constructed or finished with corrosion resistant finish. Provide floor mount flange. Provide and install wrap around curtain with each unit.
2. Unit and installation shall comply with ANSI Z358.1, latest edition.
3. Units shall be tested per ANSI Z358.1 prior to turning over to Owner. Contractor shall train Owner in proper usage per Manufacturer's Instructions and ANSI requirements.
4. Furnish each unit with all equipment necessary for field testing of emergency fixtures per ANSI Z358.1 requirements.
5. Emergency eyewash/shower units and installation shall conform to all requirements of American Disabilities Act Guidelines and ANSI A117.1. Provide and mount universal identification sign.
6. Refer to Part 2 *"Products"* of this section for Emergency Combination Eyewash/Shower Mixing Valve.

2.2. THERMOSTATIC MIXING VALVES

A. Furnish and install thermostatic mixing valves where indicated at public lavatories, and below all lavs/handsinks that are provided with hot water temperatures above 120 degrees F.

B. Thermostatic mixing valves shall be Bradley, Watts, or approved equal for installation under lavs. Provide in-line check valves, bronze body, escutcheon plates, inlet filters, and insulation as required. Thermostatic mixing valves shall be adjusted to deliver 105 degrees Fahrenheit hot water when supplied with 140 degrees Fahrenheit delivering hot water. Furnish with adjusting cap with locking feature.

C. The thermostatic mixing valves shall be ASSE standard 1016-96, ASSE 1017, ASSE 1069, and ASSE 1070 listed.

2.3. PLUMBING FIXTURE SUPPORTS

A. Wall mounted urinal supports, Josam 17810 plate type with cast iron headers, box steel stanchions, block type cast iron feet with bearing plate.

B. Support for wall mounted urinals, lavatories, sinks, drinking fountains, etc.:

1. Where fixtures are supported from concrete or cinder block walls, install No. 10 USSG Steel plate on the opposite side of the wall and bolt hangers or supports through plate. Where opposite side of wall is exposed to view, place bolts in core of blocks and fill core with cement.
2. Where lavatories with wall hangers have been specified and fixtures are supported from metal stud frame partitions, fixture brackets or mounting lugs shall be through bolted to steel channel crosspieces not less than 1-1/2-inch wide anchored to studs. Bolt heads shall be welded to channel web.
3. Concealed arm type lavatory supports, Josam 17100 with cast iron headers, box steel stanchions, block type cast iron feet and header; and chrome plated cast brass threaded escutcheons for slab type lavatories.
4. Flush mounted drinking water cooler supports, Josam 17550 plate type, box steel stanchions, block type cast iron feet.

C. Water closet chair carriers, Josam 12000 Series for horizontal and vertical installations.

2.4. HANDICAPPED LAVATORY/SINK INSULATION

A. All handicapped lavatories and sinks shall be provided with under counter pipe and trim insulation.

B. Insulation shall be fully molded "P" trap and angle valve insulated Hand-I-Lav Guard, Truebro Model #101, 102, and 105 to suit.

C. Insulation to meet ADA #4 19.4, ANSI A117.1, and International Plumbing Code.

D. Self extinguishing ASTM D635 burn characteristics, thermal conductivity ASTM C177 K-Value ' 1.17.

E. Insulation thickness to be minimum 2 inch.

2.5. EMERGENCY COMBINATION EYEWASH/SHOWER MIXING VALVES FOR SINGLE FIXTURE

A. Furnish and install factory fabricated, hot-and-cold-water-tempering equipment with dual manifold thermostatic mixing valves. Units shall be manufactured by Guardian Equipment,

Power's, Speakman, Leonard, or approved equal.

B. Thermostatic Mixing Valves: Designed to provide 85 degree F (29 degree C) tepid, potable water at emergency combination eyewash/shower stations to maintain temperature at plus or minus 5 degrees Fahrenheit (3 degrees C) throughout required 15 minute test period, and in case of unit failure to continue cold-water flow with union connections, controls, integral strainer, metal piping, adjustable high temperature limit, outlet and inlet thermometers, check stops, and where indicated a corrosion resistant enclosure.

C. Capacity Range: As scheduled on Contract Drawings.

D. Furnish each unit with painted, heavy duty mounting bracket from serving valve to panel on wall. Cabinet shall be surface mounted, stainless steel, and lockable.

E. Units shall be provided such that inlets can be rotated 360 degrees for top or bottom supply.

F. Where installed exposed in finish spaces units shall be chrome plated finish.

G. Comply with ANSI Z 358-1 2004.

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

A. Install all equipment in accordance with manufacturer's instructions.

B. Setting heights of lavatories, drinking fountains, etc., shall be as directed prior to installation and shall be coordinated with Architectural Contract Documents.

C. Install floor mounted fixtures only after finished floor has been installed.

D. Provide rubber concussion washers between vitreous china fixtures and supporting brackets.

E. Protect chromium plated trim from corrosive solutions used to clean tile work.

F. Provide white, silicone caulking where fixtures come in contact with walls and floors. Sealant shall be mildew resistant type in accordance with ANSI A-136.1.

G. Install components plumb and level.

H. Install and secure fixtures in place with wall supports, wall carriers and bolts.

I. Solidly attach water closets to floor with lug screws. Lead flashing is not intended to hold fixture in place.

J. Install flush valve handles on the open side of all ADA waterclosets in accordance with ANSI requirements.

K. Fixtures shall be vitreous china unless otherwise noted. Cast iron fixtures shall have acid resisting enamel finish unless noted otherwise, color shall be white.

L. Flush valves shall be self-closing, non-hold open type with vacuum breaker and perform satisfactorily when subject to inlet water pressure varying from 15 to 75 psi. Flush valves shall be as specified, Delaney, Zurn or approved equal.

M. Provide flexible risers and loose key stops for all lavatories and sinks. Provide 17 ga. chrome plated brass tail piece and trap with cleanout for all lavatories and sinks.

N. Fittings for fixtures supplied by others, such as science sinks are provided under another division of these specifications. Connections of these fixtures to the plumbing system are provided under this section.

O. Coordinate with plumbing piping and electrical work to achieve a complete operating system.

P. Field test all combination eyewash/shower units per ANSI Z358.1 latest edition.

Q. All plumbing vents within a 10'-0" radius of exhaust vents shall be extended to a height of 3'-0" above exhaust vent crown.

R. All plumbing vents within a 10'-0" radius of any rooftop unit or intake louver shall be extended to a height of 3'-0" above fresh air intake.

S. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.

T. Unless otherwise noted, all plumbing piping shall be routed as high as possible between bottom of roof joists and above ceiling to allow proper installation of ductwork, fire protection piping, conduits, etc.

U. Coordinate with Architectural Drawings before roughing in plumbing.

V. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.

W. See site plan for extent of all piping leaving and entering building.

X. See domestic water riser diagrams for location of valves, shock absorbers, etc.

Y. Make proper HW, CW, re-cir., waste, and vent connections to all fixtures and equipment even though all branch main, elbows and connections are not shown.

Z. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling. Domestic hot, cold and re-circ. water piping shall be installed as high as possible below roof insulation.

AA. Unless otherwise noted, horizontal sanitary piping shall be pitched 1 percent.

BB. Unless otherwise noted, all domestic water piping and fire protection piping shall be installed on heated side of roof insulation.

CC. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.

DD. For sizes of all domestic water piping see plumbing fixture schedule and domestic water riser diagrams.

EE. For sizes of all sanitary and vent piping see plumbing fixture schedule and sanitary/vent riser diagrams.

3.2. PLUMBING SPECIALTY INSTALLATION REQUIREMENTS

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

C. Secure supplies to supports or substrate.

D. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve as appropriate is not indicated.

E. Install water-supply stop valves in accessible locations.

F. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

G. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

3.3. FITTINGS FOR FIXTURES SUPPLIED BY OTHERS

A. Fixtures such as built-in-sink in counters and equipment are provided under other divisions of the specifications and are complete with strainer and tailpiece. Fittings, accessories and connection of these fixtures to the plumbing system are provided under this section.

B. Rough-in and final connection includes but is not limited to all domestic water, waste, vent, systems. Furnish stops, strainers, vacuum breakers, and under counter insulation where not furnished under another Division of these specifications.

3.4. TESTING

A. After plumbing fixtures are connected, all piping and fixtures shall be tested for operation and a smoke or peppermint test shall be made on all soil, waste and vent piping.

B. After the building has been occupied and the various equipment is in actual use, the Contractor shall make an operating test of all equipment at a time directed by the Engineer to determine that all contract requirements are met.

3.5. CLEANING AND STERILIZATION

A. After final testing for leaks, all potable water lines shall be thoroughly flushed, by plumbing contractor, to remove foreign material. Before placing the systems in service, sterilize the new water lines in accordance with local health department codes and at a minimum according to the following procedure:

1. Through a 3/4-inch hose connection in each branch main and building main, 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 system.
2. 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.
3. 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 at least three (3) hours.
4. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system. It is not necessary to retain chlorine in any system for twenty-four hours to achieve sterilization. AWWA states that 200 ppm chlorine for three hours is sufficient.
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 an independent and 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. Additionally, this report shall be forwarded to the Owner as well as be included in the O&M Manual.
9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.
10. Take precautions to avoid use of plumbing fixtures and domestic water systems during sterilization period. Place signs on all plumbing fixtures and outlets during sterilization period.

3.6. EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.7. PREPARATION

A. Review the Architect's equipment cut sheets. Confirm rough-in location and size of fixtures and openings prior to commencing work.

B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.8. INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.9. ADJUSTING

A. Adjust stops, valves, infrared fixtures for intended water flow rate to fixtures without splashing, noise, or overflow.

3.10. CLEANING

A. At completion, clean plumbing fixtures and equipment. Polish all chrome plated faucets, accessories, equipment, and piping.

B. All electric water cooler coils shall be cleaned of all construction dust and debris prior to building occupation by Owner.

3.11. FIXTURE HEIGHTS

A. Install fixtures to heights above finished floor as required by local Plumbing Code, Americans with Disabilities Act (A.D.A.), Authority Having Jurisdiction, and Architectural Contract Drawings. In the absence of a local code requirements, install fixtures to heights above finished floor as follows.

B. Water Closet

1. Standard 15 inches to top of bowl rim.
2. Handicapped 18 inches to top of seat.

C. Urinal

1. Standard 22 inches to top of bowl rim.
2. Handicapped 17 inches to top of bowl rim.

D. Lavatory

1. Standard 31 inches to top of basin rim.

2. Handicapped 34 inches to top of basin rim.

E. Drinking Fountain

1. Standard 36 inches to top of basin rim.
2. Handicapped 34 inches to top of basin rim.

F. Water Closet Flush Valves

1. Standard 11 inches min above bowl rim.
2. Recessed 10 inches min. above bowl rim.

G. Combination Emergency Shower/Eye Wash

1. Handicapped 84 inches to bottom of shower head and 38 inches to eye wash receptor rim.

END OF SECTION

DIVISION 22 SECTION 224005
PLUMBING EQUIPMENT

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SECTION 224005 - PLUMBING EQUIPMENT

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. GENERAL

A. For General Mechanical Requirements, see Division 22 Section, *Common Work Results for Plumbing* & Division 01, *General Requirements.*

B. Drawings and general provisions of the Contract, including *General and Supplementary Conditions* and Division 01 specifications apply to this Section.

C. All exposed bolts, screws, etc., shall be vandal proof.

D. All plumbing materials and equipment shall be new and of best grade, free of defects and complete with all required appurtenances and accessories.

E. Piping and insulation are specified under other sections.

F. Provide all materials, equipment and perform all labor required to install plumbing system complete as specified, as drawings indicated and as required by the State of Delaware, National Standard Plumbing Code , International Plumbing Code, the local code, and all other authorities have jurisdiction.

G. Provide stops for all plumbing equipment. Stops are to be accessible.

H. Provide pumps with manufacturer's name, model number, and rating/capacity identified.

I. Ensure products and installation of specified products are in conformance with

recommendations and requirements of the following organizations:

1. National Sanitation Foundation (NSF).
2. American Society of Mechanical Engineers (ASME).
3. National Board of Boiler and Pressure Vessel Inspectors (NBBPVI).
4. National Electrical Manufacturers' Association (NEMA).
5. Underwriters Laboratories (UL).

J. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitations, are non-overloading in parallel or individual operation, operate within 25 percent of midpoint of published maximum efficiency curve.

1.3. REFERENCES

A. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.

B. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.

C. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.

D. ANSI/ASE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

E. ANSI A112.21.1 - Floor Drains.

F. ANSI A112.21.2 - Roof Drains.

G. ANSI A112.26.1 - Water Hammer Arrestors.

H. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

I. PDI WH-201 Water Hammer Arresters.

J. ANSI/ASHRAE 90A - Energy Conservation in New Building Design.

K. ASME Section VIIID - Pressure Vessels; Boiler and Pressure Vessel Codes.

L. ANSI/NFPA 70 - National Electrical Code.

M. ANSI/NEMA 250 - Enclosure for Electrical Equipment (1000 Volts Maximum).

N. IBC - International Building Code

1.4. DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of General Requirements.

B. Accept equipment on site in factory packaging. Inspect for damage.

C. Protect installed equipment from damage by securing areas and by leaving factory packaging in place to protect equipment and prevent use.

1.5. FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings and per the manufacturer.

1.6. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. FLOOR AND ROOF DRAINS

A. Provide Nikaloy strainers on all floor drains unless specified otherwise.

B. Provide flashing clamps on all drains penetrating waterproofing membrane.

C. Provide suitable flashing material and clamping collar for drains which are not set in place when slab is poured.

D. Provide backwater valves for all floor drains connecting directly to the storm water system. Depending on conditions of the particular installation backwater valves may be an integral part of the drains or a separate device. Accessibility to valves must be maintained for maintenance. Provide an adequately sized extension sleeve up to floor or grade as required.

E. Backwater valves are normally closed, flapper type with bronze or brass seat and disc and stainless steel pin.

F. Provide traps for all floor drains connected to the sanitary system.

G. Provide E & S primer valve (one valve per trap, per floor drain) on all remote floor drains. When installed on fixture in finished area, primer valve shall be concealed behind a Josam 58650 access door. In Mechanical Rooms, mezzanines, penthouses, and all other locations indicated on the contract drawing, priming lines shall be connected to automatic trap primer.

H. Provide Josam 26200 vertical expansion joint in each rain leader that does not have 90 degrees offset downstream of the roof drain. The expansion sleeve shall be bronze and shall conduct the rain water beyond the packing. Install expansion joints in accessible locations for repacking.

I. In lieu of joints specified in piping section, neoprene gaskets may be used if designed for use with the drains and cleanouts employed and if approved by the local plumbing authority.

J. Schedule of Drains and Accessories:

1. RDR.-1: Roof Drain: Zurn Z-100 15-inch diameter roof drain, dura coated cast iron body with combination membrane flashing clamp/gravel guard and low silhouette aluminum locking dome. Provide with support ring, adjustable top with wide roof flange, large sump with anchor flange, bottom outlet inside caulk connection and deck clamp. Provide overflow drain as detailed on contract drawings.
2. FDR.-1: General Service Floor Drain: Zurn ZN-415 floor and shower drain, dura coated cast iron body with bottom outlet, combination invertible membrane clamp and adjustable collar with Type "B" polished nickel bronze strainer. Provide with ½ -inch trap primer connection.
3. FDR.-2: Mechanical Room Floor Drain: Zurn Z-566 12-inch square open top drain, dura coated cast iron body with bottom outlet, ½ top grate, large suspended cast iron sediment bucket. Provide flashing flange and ½" -inch trap primer connection.

K. Approved Manufacturers: Josam, J.R. Smith, Zurn, Wade, Ancon, Mifab, Watts.

2.2. CLEANOUTS

A. Provide cleanouts in sanitary and storm drainage systems at ends of runs, at changes in direction, near the base of stacks, every 50 feet in horizontal runs, of 4-inch diameter or less, every 100 feet in horizontal runs over 4-inches, and where indicated.

B. Cleanouts shall be full size of pipe up to 4-inches and shall be 4-inches for larger sizes. Where installed in finished floors inserts shall match adjacent floor construction.

C. Materials and Approved Manufacturers: Josam, J.R. Smith, Zurn , Wade or Ancon, Mifab, Watts, equal to Josam numbers given below:

1.	Concealed Piping	C.I. Pipe
2.	Unfinished Areas	
3.	Floors	56070
4.	Walls	58790
5.	Finished Areas - Floors	
6.	Terrazzo	56040-13
7.	Composition Tile	56000-12
8.	Ceramic Tile	56000
9.	Carpet	56070-14
10.	Carpet insert to match adjacent carpet in type, color and grade.	
11.	Finished Areas - Walls	
12.	Plaster/Dry Wall	58770
13.	Tile/CMU	58790

2.3. WALL HYDRANTS

A. Wall Hydrant (Exterior): Josam 71000 Series Hydrasan anti-siphon wall hydrant, 3/4-inch non-freeze, key operated wall hydrant with hinged locking cover, polished bronze box and cover and bronze casing and integral vacuum breaker. Seat and disc shall be removable from front of the hydrant. Wall thickness; see architectural drawings. Wall hydrants shall conform to ANSI/ASSE 1019 with wall plate, lock shield and removable key.

B. Approved Manufacturers: Josam, Wade, Zurn, J.R. Smith, Mifab, Watts, or approved equal.

2.4. SHOCK ABSORBERS

A. Provide shock absorbers equal to Josam Shokstops at all fast closing valves, at the top of all cold water risers, at each flush valve or battery of flush valves, and where indicated. Sizes and locations shall be in accordance with PDI Standard WH 201.

B. Shock absorbers shall conform to ANSI A112.26.1, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure.

C. Approved Manufacturers: Josam, Wade, Zurn, J.R. Smith, Sioux Chief, Watts, or approved equal.

2.5. VACUUM BREAKERS

A. Provide vacuum breakers on water connections to fixtures and equipment where minimum air gaps required by Plumbing Code are not possible and on hose bibbs and other outlets to which hoses can be attached.

B. Vacuum breakers not subject to back pressure, Watts No. 288A; vacuum breakers subject to back pressure, Watts Series 9D or for hose threads, Watts Series 8A.

C. Hose connection backflow preventers shall be ASSE 1052, suitable for at least 5 gpm flow and applications with up to 10 foot head back pressure. Include two (2) check valves, intermediate atmospheric vent, and non-removable, ASME B1.20.7 garden-hose thread on outlet.

D. Hose connection vacuum breakers shall be ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze finish hose connections may be rough bronze.

E. Approved manufacturers: Watts, Beeco, B&K Industries, Zurn, Sparco, Conbraco or approved equal.

2.6. HOSE BIBBS

A. Chicago Faucet No. 952 or approved equal hose and faucet. Bronze or brass with integral

mounting flange, replaceable hexagonal disc, hose threaded spout, polished chrome plated where exposed in finished areas, with hand wheel and removable key, integral vacuum breaker in conformance with ANSI/ASSE 1011.

B. Hose bibbs in finished areas shall be polished chrome finish.

C. Approved Manufacturers: Chicago Faucet, American Standard, Crane, T&S Brass, Watts.

2.7. DOMESTIC WATER CARTRIDGE TYPE RE-CIRCULATING PUMPS

A. Provide and install domestic water re-circulating pumps of the size, capacity and electrical characteristics as indicated on the contract drawings. Pumps shall be in-line cartridge circulators as manufactured by TACO, Bell and Gossett, Thrush, Armstrong, or approved equal. Units shall be U.L. listed.

B. Pumps shall be non-overloading throughout the range of the curves. Pumps shall have center line discharge for positive venting, flanged bodies, and same size suction and discharge.

C. Motors shall be permanent split capacitor with built-in overload protection. Impellers shall be non-metallic. Casings shall be bronze construction. Shafts shall be ceramic with carbon bearings. Units shall be rate for 125psi maximum pressure and 220 degrees F maximum temperature.

D. All circulators utilized for domestic water service shall be all bronze construction. Shaft orientation and junction box orientation shall be installed per manufacturer's recommendations.

2.8. ELECTRIC HYBRID HEAT PUMP DOMESTIC WATER HEATER

A. Furnish and install electric hybrid heat pump water heaters of the size, capacity, and arrangements indicated on the Contract Drawings. Heaters shall be GE, Rheem, Ruud, Stiebel Eltron, A.O. Smith, or approved equal. Water heaters shall be UL listed. The domestic water heater and installation shall meet all requirements of the State of Delaware and Regulations including amendments and addenda latest edition. The domestic water heater and installation shall comply with all requirements of the local Boiler Inspector. Contractor must submit any deficiencies cited by the Boiler Inspector to the Engineer and Owner for review.

B. Tanks shall be glass lined with magnesium anode and an approved working pressure of 125 psi. Tank shall have a steel jacket with a baked enamel finish. Electric elements shall be screw in design complete with adjustable thermostatic controls. Tank shall be insulated to conform with latest ASHRAE 90.1 Standards.

C. Unit shall utilize air side heat pump water heater and electric resistance heating element to maintain tank temperature. Furnish with LCD electronic controls, LCD display, service diagnostics, temperature setting monitoring, and “away” mode.

D. Unit shall be factory furnished with multiple operating modes including hybrid mode, high demand, heat pump only, and standard electric.

E. Entire assembly shall be provided with a one (1) year Parts and Labor Warranty. The 2nd through 10th year shall be covered by a Parts Only Warranty.

F. Accessories shall include an A.S.M.E. rated temperature/pressure relief valve, drain valve, electrical junction box, washable filter, condensate collector, condensate collection tube, and terminal block.

G. Install water heaters on 4 inch high concrete housekeeping pad unless otherwise detailed on the drawings.

2.9. BACKFLOW PREVENTER (REDUCED PRESSURE PRINCIPAL TYPE)

A. Furnish and install reduced pressure principal backflow preventers at all cold water make-up connections to HVAC water systems, lawn irrigation systems, and where indicated on contract drawings.

B. Backflow preventers shall be of bronze body construction, inlet and discharge OS&Y gate valves, stainless steel check and relief valve seats, stainless steel relief valve shafts and flange bolts. Ball valve test cocks shall be bronze body.

C. Pressure ratings shall be up to 175 psi and temperature ratings shall be up to 210 degrees F continuous.

D. Install unit per local code requirements and authorities having jurisdiction. Unless otherwise noted, install backflow preventers between 12 inches and 60 inches above finished floor.

E. Units shall be approved by ASSE 1013, UPC, UL, and shall be No. 909 with air gap fitting and inlet/outlet gate valves as manufactured by Watts Regulator, Conbraco, Wilkens, or as approved equal. Pipe discharge to nearest floor drain/floor sink. Provide minimum 18-inch clearance for servicing and testing.

F. Pipe discharge of backflow preventer full size to closest floor drain utilizing type "L" copper.

G. Furnish test kit for field testing units. Watts Model TK-9A Analog Differential Gauge or approved equal.

2.10. BACKFLOW PREVENTER (DOUBLE CHECK VALVE ASSEMBLY TYPE) (VERTICAL TYPE)

A. Furnish and install double check valve assembly backflow preventers at incoming water services and where else indicated on contract documents.

B. The assembly shall consist of two positive seating check modules with captured springs and rubber seat discs. The check module sets and seat discs shall be replaceable.

C. Service of all internal components shall be through a single access cover secured with stainless steel bolts. The assembly shall include two resilient seated isolation valves and four top mounted, resilient seated test cocks.

D. Furnish each backflow preventer with the following accessories and options:

1. OS & Y Gate Valves.
2. Ball Valve Test Cocks.
3. Approval for vertical up flow installation.

E. Provide minimum 18-inch clearance for servicing and testing.

F. The assembly shall meet the requirement of ASSE Std 1012 and AMCA Std C510.

G. Double check valve backflow preventers shall be Watts No. 709, Conbraco, Wilkens, Ancon, or approved equal.

2.11. TRAP PRIMING STATION-AUTOMATIC TRAP PRIMER

A. Trap priming stations shall be Precision Plumbing Products, Inc., Electronic Trap Priming manifold Model PT. The manifold shall supply a minimum of 2 ounces of potable water per opening at 20 PSIG once in each 24 hour period. The Electronic Trap Priming Manifold must be capable of equally priming from 4 through 30 individual floor drain traps.

B. The unit shall be factory assembled and prepiped, and shall include a bronze body 3/4-inch female NPT WOG rated ball valve 3/4-inch, Water Hammer Arrestor, copper barrel with brass piston and type "L" copper sweat connection, electronic brass body 3/4-inch solenoid valve, and type "L" copper manifold with brass 2-inch compression fitting and orifice opening for precision water distribution to each floor drain trap. Unit shall be pre-piped with atmospheric vacuum breaker.

C. Electronic components shall include single point power connection at 120 volt 1 phase 60 hertz, manual over-ride switch, minimum 5 amp breaker, 24 hour geared timer with relay and 5 second dwell function.

D. All components shall be factory assembled, tested and supplied in a 16 gauge steel enclosure suitable for surface or recess mounting, as indicated on contract drawings. In addition, all components must comply with nationally recognized standards. The Precision Plumbing Products Electronic Trap Priming Manifold shall be fully warranted for the life of the plumbing system.

E. When only a single trap primer is required, as in the case of a restroom with one floor drain in a toilet (or similar) the contractor may submit, in lieu of an electronic multiple station, a single station for review by the Engineer. The fixture serving the trap primer must be within 10' of the trap. Components shall be brass, bronze, and chrome, of the highest quality.

F. Access door shall be finished with a prime coat and fire rated where installed in a rated wall. Access door latch shall be Allen key type.

2.12. TRAP SEAL PRIMER VALVES

A. Provide and install one valve per trap, per floor drain on all remote floor drains. When installed on a fixture in a finished area, primer valve shall be concealed behind an access door. In mechanical rooms, mezzanines, penthouses, and all other locations indicated on contract drawings, priming lines shall be connected to automatic trap primer station. Trap seal primer valves shall be as manufactured by E&S, Precision Plumbing Products, Sioux Chief, Mifab, Watts, or approved equal.

B. Trap seal primer valves shall be ASSE 1018, water supply fed type with the following characteristics:

1. 125 psig minimum working pressure.
2. Bronze body with atmospheric - vented drain chamber.
3. Inlet and outlet connections: ½ inch NPS threaded or solder joint.
4. Gravity drain outlet connection: ½ inch NPS threaded or solder joint.
5. Finish: chrome plated

2.13. DOMESTIC WATER METER WITH ATC INTERLOCK CAPABILITIES

A. Furnish and install a bronze magnetic drive flanged turbo-water meter on incoming water service to building. The water meter shall be Model WPX-210 as manufactured by Niagara, Rockwell, Hersey, or approved equal. Unit shall be sized and selected so as not to exceed the scheduled maximum pressure drop at design flow.

B. Main cases for all sizes shall be cast Water Works bronze. Size, model and direction of flow shall be cast, in raised characters, on both sides of the Main cases.

Operating Characteristics		
Meter Size	Low Flow (95percent minimum)	Normal Range (100.0 +/- 1.5 percent)
2-inch	3	4 to 160
3-inch	4	5 to 350
4-inch	10	15 to 1000
6-inch	20	30 to 2000
10-inch	55	55 to 5500

1. 8-inch and 12-inch pipeline size applications can be accomplished by using the 6-inchand 10-inch size meters respectively with the appropriate tapered, concentric reducers.

C. Meters shall have performance capabilities of continuous operation up to the rated maximum flows as outlined above without affecting long term meter accuracy or causing undue wear.

Meters shall also have a 25 percent flow capacity in excess of the maximum flows listed for intermittent flow demands.

D. The measuring chamber shall be of unitized construction (i.e., complete with measuring element, calibration device and register in one assembly). The measuring chamber shall be capable of operating within above listed accuracy limits without recalibration when transferred from one main case to another. The measuring element shall be mounted on a horizontal stationary shaft with sleeve bearings and be essentially weightless in water.

E. The register shall be permanently hermetically sealed; all registers of similar size and registration to have a standard ratio gear reduction so as to permit interchange ability. The register shall be assembled to measuring chamber in a tamper proof manner so removal can be made only after measuring chamber is removed from the maincase. Sweep hand reading and odometer wheel details will conform to American Water Works Standard C-701, as most recently revised.

F. All reduction gearing shall be enclosed in the permanently hermetically sealed register. The drive magnet shall be located in the measuring element, and the follower magnet shall be located inside the permanently hermetically sealed register. An intermediate magnetically active material shall be required to distribute the magnetic flux uniformly to the follower magnet, thereby improving the service life of the register's rotating components.

G. All meters shall operate without leakage, damage or malfunction up to a maximum operating pressure of 150 pounds per square inch.

H. The 6-inch and 10-inch size meters shall have external strainers as part of the meter package. Strainers shall have cover plate for inspection and removal of debris from the bronze screen without disturbing the pipeline.

I. Flanges on 2-inch size meters shall be oval faced and drilled on the horizontal axis with a bolt circle diameter of 4 ½ -inch. Thickness shall be as required for Class 125 round flanges. Flanges for 3-inch, 4-inch, 6-inch and 10-inch size meters shall be of the Class 125 round type, flat faced, and shall conform to ANSI 16.1 for specified diameter, drilling and thickness. Companion flanges, if required with the meters, shall consist of one standard cast iron flange, tapped with American Standard internal taper pipe threads, and one flanged coupling adapter. The type and outside diameter of connecting pipe shall be provided for appropriate gasket sizing. All bolts, nuts and gaskets shall be provided.

J. Turbine meters of similar design concept must be available for purchase in all of the sizes specified above. The turbine meters must have a minimum of five (5) years of satisfactory operating experience as marketable products. Limited experimental history is not acceptable. The meter manufacturer shall submit, in writing, a price schedule of its factory maintenance program for the measuring chambers.

K. The water meter shall be fully field insulated and jacketed to prevent condensation.

L. The water meter shall be provided with a high frequency pulse output device for interface with Automatic Temperature Control System. The Infrared Pulser shall be Model 860 as manufactured by Hersey or approved equal.

M. A Pulse to DC converter shall be supplied with the Infrared Pulser. The device shall convert pulses from a variety of liquid flow sensing devices to a 4-20mA output signal which is proportional to the flow rate. This output shall transmit flow rate data over long distances with no loss of accuracy. The converter shall be Model 1005 as manufactured by Hersey or approved equal.

N. At contractor's option a water meter provided by the ATC subcontractor may be utilized.

2.14. DOMESTIC WATER EXPANSION TANKS

A. Provide and install domestic water expansion tanks of size, capacity and as indicated on contract drawings. Domestic water expansion tanks shall be Therm-X-TROL as manufactured by AMTROL Inc., Flexcon, Wessels, Taco, Armstrong, or approved equal. Mount tank as detailed on the drawings.

B. Domestic water expansion tanks shall be specifically designed for use in potable water systems. Tanks shall be pre-charged to require pressure at the factory. The maximum working pressure shall be 150 psig. The maximum operating temperature shall be 200 degrees F. Expansion tanks shall contain removable FDA approved butyl bladder.

C. Before installation, Contractor shall adjust the tank air pre-charge pressures to equal city water pressure.

D. The tank must be constructed in accordance with Section VIII of the A.S.M.E. boiler and pressure vessel code and stamped 150 psig working pressure.

E. Accessories: Pressure gauge and air charging fitting, tank drain, pre-charge as indicated on contract drawings and factory installed clip angles.

2.15. INTERIOR RECESSED WALL HYDRANTS

A. Provide and install recessed wall hydrants where indicated on the contract drawings. Recessed wall hydrants shall be Zurn Model Z 1330, Josam, Ancon, Mifab, Watts or approved equal.

B. Units shall be encased Ecotrol “anti-siphon" wall hydrant for interior wall installation.

C. Each unit shall be complete with integral backflow preventer, all bronze interior parts, non-turning operating coupling with hemispherical neoprene plunger and 3/4-inch solder inlet.

D. Furnish each unit mounted in a stainless steel box and hinged cover with operating key lock and "water" stamped on cover.

E. Furnish each unit with the following accessories:

1. 3/4 inch – 90 degrees inlet elbow with union nut

2. cylinder lock
3. key operator

2.16. INCOMING WATER SERVICE PRESSURE REDUCING VALVE

A. Furnish and install a pressure reducing valve on the incoming water service as detailed and scheduled on the Contract Drawings. Pressure reducing valve shall be a pilot operated valve as manufactured by Cla-Val, Watts, Flomatic, or approved equal.

B. Furnish with components suitable for 150 psig minimum working pressure. The interior surfaces shall comply with AWWA C550, be FDA approved and contain an epoxy coating.

C. Furnish with pilot-control valve, restrictor device, specialty fittings, and sensor piping.

D. Main valve body shall be full port, cast or ductile iron body. Disc shall be Buna-N-Rubber.

E. All flanges and fasteners shall be 316 stainless steel.

F. Furnish and install isolation valves, on valve inlet/outlet. Also furnish and install pressure gauges upstream and downstream of unit and an inlet strainer upstream of unit.

2.17. LAB TRAINING UNIT WATER SUPPLY CONNECTION BOX

1. Lab Training Unit: Provided in another Division of specifications. Under this Division provide rough-in and final connection including indirect waste outlet to floor sink and wall box.
2. Lab training unit rough-in shall include a Guy Gray recessed wall box. Wall box shall be Model TZ00TPPVC or the approved equal of Watertight. Unit shall be complete with ½ -inch NPT inlet x 3/4" hose bibb outlet. Blank-off un-used opening for hot water and drain connections. Overall dimensions shall not exceed 14-inch wide x 9 ¼ -inch high x 3 1/2 -inch deep. Box shall be 20 gauge steel finished in a white epoxy finish.

PART 3. EXECUTION

3.1. GENERAL INSTALLATION REQUIREMENTS

A. Install all equipment in accordance with manufacturer's instructions.

B. Install components plumb and level.

C. Cleanouts in vertical pipes shall be installed in tees near floor. Cleanouts in horizontal pipes shall be installed with wyes on long sweep quarter beds. Cleanouts punching water proofing membranes shall have flashing clamps. Cleanout access covers in dry wall or gypsum board shall be painted to match walls.

D. Unless otherwise noted, drains are to be installed at the low point of floors. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

E. Install floor drains in low points so the top of grates are at or below the finished floor level.

F. Drains not functioning properly shall be removed and re-installed properly at the expense of the contractor.

G. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

H. Extend cleanouts to finish floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

I. Encase exterior cleanouts in concrete flush with grade.

J. Install water heaters in accordance with manufacturer's instructions and to NSF, UL requirements and State of Delaware and Regulations.

K. Coordinate with plumbing piping and electrical work to achieve a complete operating system.

L. Install domestic water storage tanks in accordance with manufacturer's instructions.

M. Provide painted steel pipe support for tanks independent of building structural framing members.

N. Clean and flush domestic water storage tanks after installation. Seal until pipe connections are made.

O. Support piping adjacent to all pumps such that no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches (100 mm) and over.

P. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitations, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

Q. Align and verify alignment of base mounted pumps prior to start-up.

R. Provide air cock and drain connection on horizontal pump casing.

S. All plumbing, vents in exterior walls shall be offset a minimum of 3'-0" in ceiling at roof before penetration.

T. All plumbing vents within a 10'-0" radius of exhaust vents shall be extended to a height of 3'-0" above exhaust vent crown.

U. All plumbing vents within a 10'-0" radius of any rooftop unit or intake louver shall be extended to a height of 3'-0" above fresh air intake.

V. Slopes and invert elevations of all interior piping shall be established before any piping is installed in order that proper slopes will be maintained. All piping shall be located and determined where to be run to avoid conflict with other trades.

W. Unless otherwise noted, all plumbing piping shall be routed as high as possible between bottom of roof joists and above ceiling to allow proper installation of ductwork, fire protection piping, conduits, etc.

X. Coordinate with Architectural Drawings before roughing in plumbing.

Y. All openings in ceilings and plenum walls for plumbing shall be sealed air tight and protected with fire stop.

Z. See site plan for extent of all piping leaving and entering building.

AA. See domestic water riser diagrams for location of valves, shock absorbers, etc.

BB. Make proper HW, CW, re-cir., waste, and vent connections to all equipment even though all branch main, elbows and connections are not shown.

CC. Cleanouts shall be provided near base of each vertical waste or solid stack. Provide 18" minimum clearance for access.

DD. Unless otherwise noted, sanitary waste piping shown is below floor and all other piping is overhead, above ceiling. Domestic hot, cold and re-circ. water piping shall be installed between ceiling and attic insulation.

EE. Unless otherwise noted, horizontal sanitary piping pitches shall be 1 percent.

FF. Unless otherwise noted, all domestic water piping and limited area fire protection piping shall be installed on heated side of ceiling insulation.

GG. All piping and installation shall comply with all local and national plumbing codes. Test piping as required by plumbing code and authority having jurisdiction.

HH. For sizes of all domestic water piping see plumbing fixture schedule and domestic water riser diagrams.

II. For sizes of all sanitary and vent piping see plumbing fixture schedule and sanitary/vent riser diagrams.

3.2. DOMESTIC WATER HEATER INSTALLATION REQUIREMENTS

A. Install units on concrete bases, 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.

B. Anchor units to substrate.

C. Install temperature and pressure relief valves in top portion of storage tank shells of units with storage. Use relief valves with sensing elements that extend into shells. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain. Install union on relief valve discharge piping. Install automatic air vent at top of hot water supply piping with union ball valve.

D. Install pressure relief valves in water piping for units without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

F. Install vacuum relief valves in cold-water-inlet piping.

G. Install unit drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section, *Plumbing Piping, Fittings and Valves* for drain valves.

H. Install thermometers on unit inlet and outlet piping. Refer to Division 22 Section, *Plumbing Piping, Fitting and Valves* for thermometers. Install pressure gages on unit piping.

I. Fill unit with water. Install domestic water expansion tank and charge with air. Install piping adjacent to units to allow service and maintenance.

J. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union. Connect solar transfer pump piping as detailed.

K. Make connections with dielectric fittings where piping is made of dissimilar metal.

L. Electrical Connections: Power wiring is specified in Division 26 Sections. Arrange wiring to allow unit servicing.

M. Ground equipment

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.Engage a factory-authorized service representative to perform startup service.

N. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
2. Verify that piping system tests are complete.
3. Check for piping connection leaks.

4. Check for clear relief valve inlets, outlets, and drain piping .Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices. Energize electric circuits.
8. Adjust operating controls.
9. Adjust hot-water-outlet temperature settings. Do not set above 140 deg F 60 deg C unless piping system application requires higher temperature.

3.3. PLUMBING SPECIALTY INSTALLATION REQUIREMENTS

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer. Label all piping downstream of backflow preventers as "non-potable" water.

C. Field test all backflow preventers and submit test reports to Engineer. Furnish test kits as required for field testing.

D. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet.

E. Install strainers on supply side of each control valve, pressure regulator, and solenoid valve, and where indicated.

F. Install hose bibbs with integral or field-installed vacuum breaker.

G. Install wall hydrants with integral or field-installed vacuum breaker.

H. All hose bibs shall be mounted 18" above finished floor, unless otherwise specified.

I. All wall hydrants shall be mounted 24" above finished grade unless otherwise specified.

J. Install trap seal primer valves with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Install trap priming stations plumb and level with adequate access for servicing and maintenance.

K. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

L. Secure supplies to supports or substrate.

M. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or

globe valve if specific valve as appropriate is not indicated.

N. Install water-supply stop valves in accessible locations.

O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

P. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

3.4. WATER METER INSTALLATION REQUIREMENTS

A. Install water meters, piping, and specialties according to AWWA M6 and local utility's/Owner's requirements.

1. Install displacement-type water meters with shutoff valve on water meter inlet. Install valve on water meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.
2. Install compound-type water meters with shutoff valves on water meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
3. Install detector-type water meters with shutoff valves on water meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.Install roughing-in piping and specialties for water meter installation according to utility's instructions and requirements.

C. Install power and control wiring from water meter to ATC system.

D. Field insulate and jacket water meter to prevent condensation.

3.5. FITTINGS FOR FIXTURES SUPPLIED BY OTHERS

A. Fixtures such as built-in-sink in counters and kitchen equipment are provided under other divisions of the specifications and are complete with strainer and tailpiece. Fittings, accessories and connection of these fixtures to the plumbing system are provided under this section.

B. Rough-in and final connection includes but is not limited to all domestic water, waste, and vent systems. Furnish stops, strainers, vacuum breakers, and under counter insulation where not furnished under another Division of these specifications.

3.6. TESTING

A. After plumbing fixtures are connected, all piping and fixtures shall be tested for operation and a smoke or peppermint test shall be made on all soil, waste and vent piping.

B. After the building has been occupied and the various equipment is in actual use, the Contractor shall make an operating test of all equipment at a time directed by the Engineer to determine that all contract requirements are met.

3.7. CLEANING AND STERILIZATION

A. After final testing for leaks, all potable water lines shall be thoroughly flushed, by plumbing contractor, to remove foreign material. Before placing the systems in service, sterilize the new water lines in accordance with local health department codes and at a minimum according to the following procedure:

1. Through a 3/4-inch hose connection in each branch main and building main, 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 system.
2. 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.
3. 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 at least three (3) hours.
4. CAUTION: Over-concentration of chlorine and more than three (3) hours of retention may result in damage to piping system. It is not necessary to retain chlorine in any system for twenty-four hours to achieve sterilization. AWWA states that 200 ppm chlorine for three hours is sufficient.
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 an independent and 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. Additionally, this report shall be forwarded to the Owner as well as be included in the O&M Manual.
9. If any samples tested indicate the presence of coliform organisms, the entire sterilization procedure shall be repeated.
10. Take precautions to avoid use of plumbing fixtures and domestic water systems during sterilization period. Place signs on all plumbing fixtures and outlets during sterilization period.

3.8. EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.9. PREPARATION

A. Review the Architect's equipment cut sheets. Confirm rough-in location and size of fixtures and openings prior to commencing work.

B. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.10. INTERFACE WITH OTHER PRODUCTS

A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.11. CLEANING

A. At completion, clean plumbing equipment.

END OF SECTION

DIVISION 23 SECTION 230500
COMMON WORK RESULTS FOR HVAC
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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2. SUMMARY

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

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, ductwork, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 23 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.3. PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File

necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the Division 01,*General Requirements* of the specification.

1.4. EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for contractors' failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.5. CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 23 shall be fully qualified and acceptable to the Architect/Engineer and Owner. Submit the following evidence when requested:

1. A list of not less than five comparable projects which the Contractor completed.
2. Letter of reference from not less than three registered professional engineers, general contractors or building owners.
3. Local and/or State License, where required.
4. Membership in trade or professional organizations where required.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.6. MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.7. FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.8. REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

B.	AABC	-	Associated Air Balance Council
C.	ACCA	-	Air Conditioning Contractors of America
D.	ACGIH	-	American Conference of Governmental Industrial Hygienist
E.	AIHA	-	American Industrial Hygiene Association
F.	ASA	-	Acoustical Society of America
G.	ADC	-	Air Diffusion Council
H.	AMCA	-	Air Movement and Control Association
I.	ANSI	-	American National Standards Institute
J.	ARI	-	Air Conditioning and Refrigeration Institute
K.	ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers

L.	ASME	-	American Society of Mechanical Engineers
M.	ASPE	-	American Society of Plumbing Engineers
N.	ASTM	-	American Society for Testing and Materials
O.	AWWA	-	American Water Works Association
P.	CS	-	Commercial Standard
Q.	FM	-	Factory Mutual
R.	IBC	-	International Building Code
S.	IEEE	-	Institute of Electrical and Electronics Engineers
T.	MSSP	-	Manufacturers Standards Society of the Valve and Fittings Industry
U.	NEC	-	National Electrical Code
V.	NEMA	-	National Electrical Manufacturers Association
W.	NFPA	-	National Fire Protection Association
X.	SMACNA	-	Sheet Metal and Air Conditioning Contractors National Association
Y.	TEMA	-	Tubular Exchanger Manufacturers Association
Z.	UL	-	Underwriters' Laboratories

AA. All mechanical equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled *Codes and Standards*.

1.9. SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6)copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to

this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

I. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.10. SHOP DRAWINGS

A. Prepare and submit shop drawings for all mechanical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from

that shown on contract drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. Items and Systems

Access Doors/Panels including layouts and locations
Air Monitoring Stations
Air Handling Units
Air Distribution Systems
Air Separators
Antifreeze Fluids
Automatic Temperature Control Systems and Equipment
Backfill Sand
Central Control and Monitoring Systems (CCMS) and Equipment
Chemical Feed Systems
Condensate Pumps
Coordinated Drawings
Direct Buried Piping
Drip Pans
Duct Materials
Energy Recovery Ventilators
Equipment Rails
Expansion Tanks and Accessories
Exterior Equipment/DuctPiping Supports
Fans
Filters
Filter Housings
Fire Stopping - Methods and Materials
Flow Measuring Stations
Flowmeter and Primary Elements (Flow Fittings)
Geothermal Heat Pumps
Geothermal Exterior Piping
Geothermal Interior Piping
Grilles, Registers, Diffusers
Grout
Identification Systems
In-Line Circulators
Louvers
Material and Equipment Lists
Operations and Maintenance Manuals
Pipe Enclosures
Pipe Guides and Anchors
Pipe Materials Including Itemized Schedules

Preliminary Testing and Balancing Reports
Pressure Relief Valves
Pressure Regulating Valves
Pumps
Roof Curbs
Split System Heat Pumps
Test Certificates
Thermal Insulation Materials Include Table Summaries
Thermometers and Gauges
Variable Frequency Drive Motor Bearing Protective Rings
Variable Refrigerant Volume Equipment
Variable Speed Drives
Vertical In-Line Pumps
Vibration Isolation Materials
Water Treatment Services
Weatherproof Assembly Components
Wiring Diagrams, Flow Diagrams and Operating Instructions

E. Contractor, additionally, shall submit for review any other shop drawings as required by the Architect. No item shall be delivered to the site, or installed, until the Contractor has received a submittal from the Engineer marked *Reviewed* or *Comments Noted*. After the proposed materials have been reviewed, no substitution will be permitted except where approved by theArchitect.

F. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.11. SUPERVISION AND COORDINATION

A. Provide complete supervision, direction, scheduling, and coordination of all work under the Contract, including that of subcontractors.

B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, ductwork, equipment, and other work performed under Division 23.

C. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

D. Coordinate electrical work required under Division 23 with that under Division 26. Coordinate all work under Division 23 with work under all other Divisions.

E. Supply services of an experienced (10 year minimum) and competent Project Manager to be in constant charge of work at site.

F. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until

clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.

G. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the intent of the contract documents.

H. Coordinate installation of large equipment requiring positioning before closing in building.

1.12. CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 23. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

1.13. PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where pipes penetrate roofs, flash pipe with Stoneman*Stormtite,* Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer’s instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.14. CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 23. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.15. EXCAVATION AND BACKFILLING

A. General

1. Perform all necessary excavation, or installation of work under Division 23, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill. Refer to Division 23, Ground Loop Heat Pump Piping for additional backfill requirements of ground loop piping.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.16. DRIVE GUARDS

A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.

B. When available, guards shall be factory fabricated and furnished with the equipment. Otherwise fabricate guards of heavy gauge steel, rigidly braced, removable, and finish tomatch equipment served. Provide openings for tachometers. Guards shall meet local, State and O.S.H.A. requirements.

1.17. VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors and/or foundations required to prevent transmission of vibration from equipment, piping or ductwork to building structure. See Division 23Section,*Vibration Control for HVAC, Plumbing and Fire Protection Equipment.*

1.18. ALTERNATES

A. Refer to Division 01, -*Alternates* for description of work under this section affected by alternates.

1.19. FASTENERS

A. All fasteners located in public spaces including classrooms, corridors, lobbies, toilet rooms, etc., shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

1.20. DEFINITIONS

A. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

C. *Contractor* means the mechanical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

D. *Piping* includes pipe, all fittings, valves, hangers, insulation, identification, and other accessories relative to such piping.

E. *Ductwork* includes duct material, fittings, hangers, insulation, sealant, identification and other accessories

F. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction.

G. *Exposed* means not installed underground or *concealed* as defined above.

H. *Invert Elevation* means the elevation of the inside bottom of pipe.

I. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

J. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

K. *SCR*: Silicon Controlled Rectifier: Solid state switching device to provide fast, infinitely variable proportional control.

L. *ECM*: Electronically Commutating Motor.

M. *Building Line:* Exterior wall of building.

N. *Water to Wire Efficiency*: The energy applied to the water (in kW) divided by the power input (in kW) to the variable speed drive.

1.21. MINIMUM EFFICIENCY REQUIREMENTS

A. All heating, ventilating, and air conditioning equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

B. All piping, ductwork, and equipment insulation shall comply with ASHRAE Standard 90.1, latest edition.

C. All service water/heating equipment shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

D. All mechanical devices, controls, accessories, and components shall be manufactured to provide the minimum efficiency requirements as specified in ASHRAE Standard 90.1, latest edition.

1.22. SYSTEM INTEGRATION

A. For all HVAC equipment specified to be provided with packaged controls and interfaced with the automatic temperature control system provide system integration between the equipment manufacturer and the automatic temperature control subcontractor.

B. HVAC equipment submittals requiring system integration as defined above must identify all required system integration points.

C. HVAC equipment manufacturers must coordinate with ATC subcontractor regarding system integration prior to submitting on the equipment.

D. A system integration meeting must be arranged by the Mechanical Contractor and include, but not be limited to the systems integrator for the HVAC equipment manufacturer and the ATC Subcontractor. This portion of systems integration must occur prior to HVAC equipment being delivered to the project.

E. Once the HVAC equipment is on site, a second systems integration meeting must be arranged by the Mechanical Contractor to coordinate the packaged controls with the ATC system. The HVAC equipment manufacturer's representativefamiliar with system integration and the ATC subcontract familiar with programming must be present.

F. A final system integrations meeting shall occur once all equipment is in place and ready for operation. The Mechanical Contractor, the HVAC equipment system's integrator, and the ATC Subcontractor shall meet on site to jointly program, schedule, verify points, interlock devices, and fully set up all systems integration components.

G. All systems integration coordination, programming, and graphics must be completed prior to requesting commissioning and/or inspections by the Engineer of Record.

PART 2. ELECTRICAL REQUIREMENTS

2.1. GENERAL MOTOR AND ELECTRICAL REQUIREMENTS

A. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 23 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 23. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 23.

B. All electrical work performed under Division 23 shall conform to the applicable requirements of Division 26 and conforming to the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA.

C. Provide wiring diagrams with electrical characteristics and connection requirements.

D. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

E. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

F. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor and efficiency.

G. Motors located in exterior locations, wet air streams, air cooled condensers, humidifiers air streams, and outdoors shall be totally enclosed weatherproof epoxy-treated type.

H. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

I. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.

J. All single phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

2.2. MOTORS AND CONTROLS

A. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

B. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG l.

C. Motors used with variable-frequency controllers shall have ratings, characteristics, and features coordinated with and approved by the variable frequency controller (drive) manufacturer. As a minimum the following shall apply to variable frequency controlled motors:

1. Motors shall be manufactured to withstand peak voltages of 1600 volts with .1 microsecond rise time per NEMA MG-1.
2. Critical vibration frequencies of motor shall not be within operating range of variable frequency controller output.
3. Temperature rise: Match rating for Class B insulation.
4. Insulation: Class F.
5. Thermal Protection: Conform to MG1 requirements for thermally protected motors.

D. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.
2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR^2 of the driven equipment to operating speed.

3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.
4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be 3 phase unless otherwise noted.
5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

E. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of such mechanical equipment as fans, unit heaters, humidifiers and damper controllers. When approved by the Engineer, deviations from the specifications will be permitted as follows:

1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.
2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.

F. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.

G. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1HP and above to	85.5 percent	84 percent
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
5HP	89.5 percent	87 percent
7½ HP	91 percent	86 percent
10HP	91.7 percent	85 percent
15HP	93.0 percent	85 percent
20HP	93.0 percent	86 percent
25HP	93.6 percent	85 percent
50HP and above	94.5 percent	88 percent
60 HP	95.0 percent	90 percent
75HP	95.0 percent	90 percent
100 HP	95.4 percent	90 percent
125 HP	95.8 percent	95 percent
150 HP and above	96.0 percent	95 percent

H. Three phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

I. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated.

J. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.

K. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.

2.3. MOTOR INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors to support shaft regardless of shaft position.

C. Check line voltage and phase and ensure agreement with nameplate. Check that proper thermal overloads have been installed prior to operating motors.

D. Use adjustable motor mounting bases for belt-driven motors.

E. Align pulleys and install belts.

F. Tension belts according to manufacturer's written instructions.

2.4. WIRING DIAGRAMS

A. The Contractor is responsible for obtaining and submitting wiring diagrams for all major items of equipment.

B. Wiring diagrams shall be provided with shop drawings for all equipment requiring electric power.

C. Provide wiring diagrams for all major mechanical items of equipment to electrical contractor and ATC subcontractor for coordination.

2.5. VARIABLE FREQUENCY DRIVE MOTOR BEARING PROTECTIVE RINGS:

A. For all motors driven by a variable frequency PWM drive include a maintenance free, circumferential, conductive micro fiber shaft grounding ring to discharge shaft currents. Grounding rings shall be manufactured by AEGIS SGR or approved equal.

B. Furnish units with one year warranty.

C. Size and select Bearing Protective Rings per the manufacturer requirements based on the motor size, shaft diameter, and shaft shoulder length. For motors with slingers furnish and install NEMA /IEC kit as required.

D. Furnish and apply Colloidal silver shaft coating to all shafts with Bearing Protective Rings to improve shaft voltage discharge capability.

PART 3. EXECUTION

3.1. EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect.

C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.2. SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For un-insulated copper piping provide copper hanger to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Concrete housekeeping pads and foundations shall be not less than 4 inches high and shall extend a minimum of 6 inches beyond equipment bases. Provide wire-mesh reinforcement; chamfer exposed edges and corners; and finish exposed surfaces smooth.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4. PROVISIONS FOR ACCESS

A. The contractor shall provide access panels and doors for all concealed equipment, valves,strainers,dampers,filters,controls,control devices,cleanouts,fire dampers,damper operators,traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.5. PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 23 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed ductwork, piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by theArchitectand conform to ANSI Standards.

H. All exterior ductwork, equipment, piping, breeching, and vents shall be painted to match roof in color as selected by Architect.

I. All exposed ductwork, piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

J. All exposed ductwork, piping, equipment, etc., in Mechanical Rooms, Geothermal Pump Rooms, and Storage Rooms where PVC jacketed shall not require painting. Label and identify and color code as specified.

3.6. CLEANING OF SYSTEMS

A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Blow out and flush piping until interior surfaces are free of foreign matter.

B. Flush piping in re-circulating water systems to remove cutting oil, excess pipe joint compound, solder slag and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of service company used.

C. Maintain strainers and dirt pockets in clean condition.

D. Clean fans, ductwork, enclosures, registers, grilles, and diffusers at completion of work.

E. Install filters of equal efficiency to those specified in permanent air systems operated for temporary heating during construction. Replace with clean filters as specified prior to acceptance and after cleaning of system.

F. Pay for labor and materials required to locate and remove obstructions from systems that are clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

G. Leave systems clean, and in complete running order.

3.7. COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

B. Submit color of factory-finished equipment for acceptance prior to ordering.

3.8. PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping, ductwork, and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.9. OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

D. Do not use mechanical systems for temporary services or temporary conditioning during construction, unless approved by Owner in writing. Refer to Division 01 Section *"Temporary Facilities and Controls"* for temporary heating/cooling during construction.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.10. IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged.

C. All items of equipment, including motor starters, disconnects and ATC panels shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal).

D. Provide six (6) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Record and Information Booklet* as hereinafter specified.

E. All lines pipingand ductwork installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and ductwork and service. Refer to Division 23Section,*HVAC Piping, Fittings, Valves, Etc.* and Division 23Section,*HVACAir Distribution*. Color-code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for mechanical identification. Submit samples of equipment identification cards, piping labels, ductwork labels, and valve tags to Engineer for review prior to installation.

G. Provide at least16 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section,*Instrumentation & Controls of HVAC & Plumbing Systems.*

H. Contractor shall demonstrate Sequences of Operation of all equipment in presence of Owner's representative, Engineer, and ATC subcontractor.

3.11. WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by ducts, piping or conduit under Division 23 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 23Section,*Vibration Control for HVAC, Plumbing and Fire Protection Equipment.*

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07Section,*Fire Protection, HVAC & Plumbing*

Penetration Firestopping.

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.

E. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

F. Ductwork sleeves: 20 gauge galvanized steel.

3.12. RECORD DRAWINGS

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architectone complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.13. WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the GENERAL CONDITIONS.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner.

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

3.14. LUBRICATION

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Record and Information Booklet.

B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

3.15. OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have preparedsix(6)copies of the Record and Information Booklet and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manuals – Delaware Technical & Community College Sustainable Energy Training Center - HVAC.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor’s warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Complete catalog data on each piece of heating and air conditioning equipment furnished including approved shop drawing.
4. Manufacturer's extended limited warranties on equipment including but not limited toair conditioning compressors,storage tanks,heat pumps,andgeothermal exterior piping.
5. Chart form indicating frequency and type of routine maintenance for all mechanical equipment. The chart shall also indicate model number of equipment, location and service.
6. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
7. Provide supplier and subcontractor’s names, address, and phone number.
8. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
9. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style,

service and location. Each valve chart shall be enclosed in a durable polymer based frame with a cover safety glass.

10. Copy of the approved balancing report including duct leakage data.
11. ATC systems including as-built ATC drawings of systems including internal of all panels.
12. Access panel charts with index illustrating the location and purpose of access panels.
13. Approved Health,Pressure Vessel Inspector, and Electrical Certificates.
14. Start-up reports for equipment.
15. Water treatment test reports.
16. Provide and install in locations as directed by Owner, filter charts, including filter type, size, model number, manufacturer, quantity and size for each filter utilized on the project. Filter charts shall be enclosed in a durable polymer based frame with a cover safety glass.
17. Insert color graphic with embedded perimeters for ATC system into record and information booklet.

D. Submit Record and Information Booklets prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Record and Information booklets be reviewed and approved.

3.16. INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following:

1. Complete Ductwork, Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with lights, electrical equipment, HVAC equipment and structural amenities.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

D. Refer to Division 01 Section "*Project Management and Coordination*" for additional requirements related to coordination drawings.

3.17. PIPING SYSTEMS TESTING

A. The entire new HVAC piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of

four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	**TEST PRESSURE**
Geothermal Interior Heat Pump Piping, Including Chemical Treatment Piping	100 psi
Geothermal Exterior Heat Pump Piping	See Division 02
Refrigerant Piping	400 psig

B. Ductwork pressure testing shall be as specified in another division of these specifications.

C. Testing and acceptance thereof shall be in accordance with localrequirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

D. Refrigerant piping shall be tested utilizing nitrogen per equipment manufacturer's requirements.

3.18. EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve this contractor of any responsibility for improper equipment operation.

3.19. ADDITIONAL FILTERS AND BELTS

A. One complete set of additional filters and belts shall be turned over to the owner upon final acceptance of the building by the owner. Provide correspondence to the Engineer (copy) documenting that additional filters and belts have been turned over to Owner.

B. All filters and belts shall be tagged and identified for equipment served. Furnish filters in protection wrap.

END OF SECTION

DIVISION 23 SECTION 230505
HVAC PIPING, FITTINGS AND VALVES
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SECTION 230505 - HVAC PIPING, FITTINGS AND VALVES

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. SUMMARY

A. The conditions of the contract and other general requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 23 Section, *Common Work Results for HVAC* and Division 01, *General Requirements*.

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

1.3. SYSTEM DESCRIPTION CONDITIONS

A. Provide all labor and materials necessary to furnish and install all piping systems on this project as herein specified and/or shown on the drawings. Final connections to equipment furnished in other sections of the specifications shall be included under this section.

B. All piping and insulation installed in ceiling plenums must be plenum rated and comply with NFPA and International Building Code (IBC).

C. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

D. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus

connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

E. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.

F. Provide pipe hangers and supports in accordance with ASTM B31.9 and MSS SP69 unless indicated otherwise.

G. Use spring loaded "silent" check valves on discharge of all pumps.

H. Use 3/4 inch (20 mm) ball valves with cap and chain for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to nearest floor drain.

I. At all runout piping serving equipment, use swing joints with elbows to prevent excessive movement of piping due to expansion.

1.4. QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulation. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

C. Welders Certification: In accordance with ASME Section 9.

D. Maintain one copy of each document on site.

1.5. DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle products to site under as hereinbefore specified.

B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

C. Provide temporary protective coating on cast iron and steel valves.

D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed systems.

1.6. ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet or frozen.

1.7. EXTRA MATERIALS

A. Provide one (1) repacking kit for each size valve.

1.8. ALTERNATES

A. Refer to Division 01 - *Alternates* for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. PIPE MATERIALS

A. All materials, unless otherwise specified, shall be new and of the best quality of their respective kinds, and shall conform to the requirements and ordinances of local, state and insurance authorities having jurisdiction.

1. Direct Buried Exterior Geothermal Energy Recovery Piping:
Refer to Division 23 Section, *Ground Loop Heat Pump Piping*.

2. Interior Geothermal Water Source Heat Pump Supply & Return Piping, Chemical Treatment Piping:

a). Pipe: Schedule 40 Black steel pipe, ASTM A53 inch and smaller - Type F, ASTM A53 steel (CW) with threaded joints
2 1/2 inch and larger - Grade B, Type E, ASTM A53 steel (ERW) with welded, flanged or grooved joints.

b). Fittings & Joints: 2-1/2 inches & larger, schedule 40 wrought steel ASTM Std. B16.9 long radius welding; 2-inches & smaller 125 lb. std. cast iron screwed, ASTM Standard B16.4. Joints shall be threaded or AWS D1.1 welded. Victaulic or approved equal grooved joints shall also be acceptable.

c). Flanges: Wrought steel Class 150 welding neck. ASTM Standard B16.5.

d). Groove: MI or ductile iron. Rolled form grooves only. Cut grooves are prohibited.

e). Gate Valves: 4 inches & larger - IBBM, 150 lb. OS&Y flanged; 2 inch & smaller - 150 lb. Bronze body bronze trim.
For valves 4 inch and larger located in mechanical equipment spaces 10'-0-inches or greater above finished floor, valve shall have chain wheel operators with chains extending to within 6 feet –0 inches above finished floor. Chain wheels and guides shall be galvanized.

f). Ball Valves: Shut-off valves 3 inch and smaller shall be ball valves. Ball valves shall be 150 lbs, bronze body, standard port, 2 piece body, TFE seats with bronze trim. Ball valves shall be threaded end or solder end as required to accommodate piping. Ball valves shall be as manufactured by Conbraco, Crane, Apollo, Nibco, Watts or approved equal.

g). Globe Valves: 2-1/2 inches & larger - IBBM, 125 lb.std. flanged, with No. 1 disc; 2 inch & smaller - bronze 150 lb.std. screw ends, with #1 disc.

h). Check Valves: 2-1/2 inches & larger - IBBM, 125 lb.std. flanged swing check, with metal disc; 2 inch & smaller - 125 lb. std. screwed. Provide "silent" spring loaded check valves at all pump discharges.

i). Balancing Valves: DeZurik Series 100, Fig. 118 or approved equal, cast iron construction, stainless steel bearings, nickel seats (3 inches and larger) non-lubricated, eccentric plug with chlorobutyl rubber or Bunz-N resilient faced plugs suitable for 250 degrees Fahreneheit, semi-steel screwed with fig. 159, removable lever and open. nut for valves 3 inches and smaller. For valves 4 inches and larger, provide gear operators and flanged connections. Provide chain operated valves for sizes 4 inches and larger located 10 feet – 0 inch or more above finished floor. Chains shall extend to within 6 feet –0 inch above finished floor. All valves shall have adjustable memory stop. Chain wheel and guide shall be galvanized.

j). Butterfly Valves: DeZurik, high performance, Keystone K-Loc, or Vic. Master Seal, type with infinite position lever (for 3 inches and smaller) double seat type and memory stop. Provide gear operator on valves 4-inches and larger. For valves 4 inches and larger located 10 feet –0 inch or more above finished floor shall be provided with chain operators with chains extending to within 6'-0-inches above finished floor. Chain wheel and guide shall be galvanized.

k). Combination Shut-off/Balancing Valves:
Taco Circuit Setter, Bell & Gossett Circuit Setter Plus, Flowset Accuset, Gerand, or as approved equal, 2 inches- 3 inches 300 lb. rated ball valve with bronze body/brass ball construction with glass and carbon filled TFE seats, in-line flow meter and balancing and shut-off valve with built in ball valve for flow adjustment. Valve shall have memory stop, calibrated nameplate, Schrader valve connections and preformed molded insulation. Valves shall be leaktight at full rated working pressure. Provide differential pressure gauge portable readout meters at 1 percent accuracy, 10 ft. length hoses, shut-off valves, vent valves, carrying case and balance valve calculator, Taco Model; 789, B&G R0-4, or as approved equal. Balance valve size shall be selected based on manufacturer's acceptable flow range and design flow rate. Pressure drop through combination shut off balance valves shall not exceed 5 feet of head at design flow rate.

l). Extended Valve Stems: Provide and install round collar type extended valve stems on all valves installed in insulated piping. Valve stem and collar shall be selected to suit insulation thickness and maintain valve handles outside of insulation.

m). Alternate:

i. At contractors option, all interior water source heat pump supply and return lines may be copper type *L* (ASTM Std. B88) with wrought copper fittings (ASTM Std. B 16.22) with brazed or 95-5 silver solder joints lead and antimony based solders are prohibited and all bronze valves may be used on piping 2-inches and less in size. Pro-Press piping with mechanical fittings may also be utilized at the Contractors option.

3. Refrigeration Piping:

   a). Tube Size ¾ -inch & Smaller:
   ASTM B280, copper tube; Type ACR, soft annealed temper fittings; cast copper-alloy fittings for flared copper tubes; flared joints. Fittings shall be ASME B16.22, wrought copper . Joints shall be bronzed, AWS A5.8, BCUP silver/phosphorous/copper alloy with melting range 1190 to 1480 degrees F.

   b). Tube Size 7/8 inch through 4-1/8inches:
   Copper tube, Type ACR, soft annealed temper; wrought-copper, solder-joint fittings; solder joints.

   c). Soldered Joints: Solder joints using silver-lead solder, ASTM B 32, Grade 96 TS.

   d). Brazed Joints: Braze joints using American Welding Society (AWS) classification BCuP-4 for brazing filler metal.

   e). Flexible connectors: 500-psig (3450-kPa) minimum operating pressure; stainless-steel core and high-tensile stainless-steel-braid covering; dehydrated, pressure tested, minimum 7 inches (180 mm) long.

   f). Diaphragm Packless Valves:
   500-psig (3450-kPa) working pressure and 275 degrees Fahrenheit (135 degrees C) working temperature; globe design with straight-through or angle pattern; forged-brass or bronze body and bonnet, phosphor bronze and stainless-steel diaphragms, rising stem and handwheel, stainless-steel spring, nylon seat disc, and with solder-end connections.

   g). Packed-Angle Valves: 500-psig (3450-kPa) working pressure and 275 degrees Fahrenheit (135 degrees C) working temperature; forged-brass or bronze body, forged-brass seal caps with copper gasket, back seating, rising stem and seat, molded stem packing, and with solder-end connections.

   h). Check Valves: Smaller Than NPS 1 (DN 25): 400-psig (2760-kPa) operating pressure and 285 degrees Fahrenheit (141 deg Celsius) operating temperature; cast-brass body, with removable piston, polytetrafluoroethylene seat, and stainless-steel spring; globe design. Valve shall be straight-through pattern, with solder-end connections.

   i). Check Valves: NPS 1 (DN 25) and Larger: 400-psig (2760-kPa) operating pressure and 285 degrees Fahrenheit (141 deg Celsius) operating temperature; cast-bronze body, with cast-bronze or forged-brass bolted bonnet; floating piston with mechanically retained polytetrafluoroethylene seat disc. Valve shall be straight-through or angle pattern, with solder-end connections.

   j). Service Valves: 500-psig (3450-kPa) pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.

   k). Solenoid Valves: Comply with ARI 760; 250 deg Fahrenheit (121 deg Celsius) temperature rating and 400-psig (2760-kPa) working pressure; forged brass, with polytetrafluoroethylene valve seat, 2-way, straight-through pattern, and solder-end connections; manual operator; fitted with suitable NEMA 250 enclosure of type required by location, with 1/2-inch (16-GRC) conduit adapter and 24-V, normally closed holding coil.

4. Cooling Coil A/C Condensate Drain Piping:

a). Pipe & Fittings: A/C condensate drain piping shall be PVC piping, ASTM D1785 Schedule 40 with ASTM D2466 Socket fittings for schedule 40. Join PVC piping fittings utilizing solvent cement ASTM D-2564 with primer ASTM F-656.

B. Steel pipe shall be similar and equal to National Tube Company, Grinnell, Republic, or Bethlehem black or zinc-coated (galvanized) as hereinafter specified. Pipe shall be free from all defects which may affect the durability for the intended use. Each length of pipe shall be stamped with the manufacturer's name.

C. Copper pipe shall be Revere, Anaconda or Chase with approved solder fittings.

D. Welding fittings for steel pipe shall meet the requirements of ASTM Standard A-23 and shall be standard catalog products. Fittings fabricated by metering and notching pipe will not be accepted.

2.2. PIPE HANGERS, ROLLER SUPPORTS, ANCHORS, GUIDES, AND SADDLES

A. All hangers for metallic piping shall be adjustable, wrought clevis type, or adjustable malleable split ring swivel type, having rods with machine threads. Hangers shall be Grinnell Company's Figure 260 for pipe ¾-inch and larger, and Figure 65 for pipe 2-inches and smaller, or approved equal. Adjustable pipe stanchion with U-bolt shall be Grinnell Company's Figure 191. Pipe roller supports shall be Grinnell's Figure 181 or Figure 271. Exterior pipe hangers shall be galvanized or stainless steel construction. For copper piping in direct contact with the hanger, hanger construction shall be copper coated to prevent contact of dissimilar metals similar to Grinnell's Figure CT-65. Hanger spacing and rod sizes for steel and copper pipe shall not be less than the following:

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
3/4 & 1	6	5	3/8
1 - ½	6	8	3/8
2	8	8	3/8
2 – ½	10	9	½
3	12	10	½
4	14	12	5/8
5	14	12	5/8

NOMINAL PIPE SIZE IN	STD. STEEL PIPE	MAXIMUM SPAN FT. COPPER TUBE	MINIMUM ROD DIAMETER INCHES OF ASTM A36 STEEL THREADED RODS
6	16	14	3/4
8	18	16	7/8
10	20	18	7/8
12	20	18	7/8

B. Install hangers for cooling coil A/C condensate PVC piping with the following maximum horizontal spacing and minimum rod diameter.

1. Up to NPS 1 ½ and NPS 2 (DN and DN50): 36 inches with 3/8 inch (10-mm) rod.

C. Install supports for vertical PVC piping every 48 inches (1200 mm).

D. Anchors, guides, and roller supports shall be installed in accordance with the contract drawings and manufacturer's recommendations to provide pipe support and control pipe movement for all piping systems. Anchors and guides shall be securely attached to the pipe support structure. Submit shop drawing for proposed pipe support structure for guides and anchors for approval of the Structural Engineer. Pipe alignment guides shall be Fig. 255 Grinnell, or as approved equal. Guides shall be sized to accommodate the pipe with insulation. Guides shall be steel factory, fabricated, with bolted two section outer cylinder and base for alignment of piping and two section guiding spider for bolting to pipe.

E. Hangers for pipe sizes ½ to 1 ½ inch (13 to 38 mm): Carbon steel, adjustable swivel, split ring.

F. Hangers for cold pipe sizes 2 inches (50 mm) and over: Carbon steel, adjustable, clevis.

G. Hangers for cold pipe sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.

H. Hangers for cold pipe sizes 6 inches (150 mm) and over: adjustable steel yoke, cast iron roll, double hanger.

I. Multiple or Trapeze hangers: Steel channels with welded spacers and hanger rods.

J. Multiple or Trapeze hangers for hot pipe sizes 6 inches (150 mm) and over: Steel channels with welded spacers and hanger rod, cast iron roll.

K. Wall support for pipe sizes to 3 inches (76 mm): cast iron hook

L. Wall support for pipe sizes 4 inches (100 mm) and over: Welded steel bracket and wrought steel clamp.

M. Wall support for hot pipe sizes 6 inches (150 mm) and over: welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

N. Vertical Support: Steel riser clamp.

O. Floor support for cold pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

P. Floor support for hot pipe sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

Q. Floor support for hot pipe sizes 6 inches (150 mm) and over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

R. Copper pipe support: Carbon steel ring, adjustable, copper plated.

S. Hanger rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

T. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.3. VALVES

A. Provide parts list and assembly drawings (exploded view) for all valves in shop drawing submittals. Provide valves of the same type by the same manufacturer.

B. Check valves in base mounted pump discharges shall be of the vertical type and shall be Miller "non-slam" check valves or approved equal suitable for service intended. Check valves in circulator discharges shall be horizontal type.

C. Provide at each base mounted pump a suction diffuser of size and type shown on drawings. Units shall consist of a cast iron angle type body with inlet vanes, magnetic insert, and blowdown connection tapped gauge post, 125 psi ANSI flange and a combination stainless steel diffuser strainer with 3/16-inch diameter opening for pump protection. Unit shall be equipped with a disposable fine mesh start up strainer which shall be removable after 30 days. Flow direction shall be from inside the strainer to outside for ease of service and cleaning. The body shall fit the pump and connecting pipe size. The unit shall be provided with an adjustable support foot to relieve piping strains from the pump suction. Suction diffuser shall be Taco "SD" Series Catalog 300-4.1, Bell and Gossett Model FLG, Armstrong, or approved equal.

D. Multi-purpose valve (non-slam check valve, throttling valve, shut-off valves and calibrated balancing valve) shall be provided at discharge side of constant speed pumps. The valve shall be of heavy-duty cast iron construction with standard ANSI flanged connections and rated for a maximum working pressure of 175 psig at 240^{o}F. The valve shall be fitted with a stainless steel stem or stem sleeve and brass seat with "O" ring seal. Valve shall be Taco "Plus One" Number 300-4.2, Bell and Gossett 3DS Triple Duty Valve, Armstrong, or as approved equal, and shall have check and plug valve features plus a memory stop with

pointer and scale. Provide additional shut-off valve to allow servicing of check valve if a multipurpose valve is utilized in lieu of separate check, shut-off, and balance valve. Provide additional shut-off valve downstream of multi-purpose valve to allow servicing of multi-purpose check valve feature. Provide pre-manufactured, removable insulation covers for all multipurpose valves.

E. Do not install multipurpose valves or balance valves on the discharge of variable speed pumps.

2.4. AUTOMATIC FLOW CONTROL VALVES

A. Automatic flow control valves shall be provided and installed where indicated. Units shall be factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain and be factory marked with the zone identification, valve number and flow rate. Valves shall be line size and shall be Model AC or WU as manufactured by Flow Design, Inc., Griswald Controls, Bell & Gossett, or approved equal.

B. Valves shall be selected for 2 - 32 psig flow range. Furnish valves with extended valve handle, stem extender, ball valve, flow regulator and unions.

C. Design:

1. The GPM for the automatic flow control valves shall be factory set and shall automatically limit the rate of flow to within 5% of the specified GPM over at least 95 percent of the control range.
2. For ½ -inch – 2-inches, the flow cartridge shall be removable from the Y-body housing without the use of special tools to provide access for regulator change-out, inspection and cleaning without breaking the main piping. (Access shall be similar to that provided for removal of a Y-strainer screen).
3. Pump Head Requirements: the permanent pressure loss added to the pump head shall not exceed seven feet.
4. Each valve shall have two P/T ports.
5. All automatic flow control devices shall be supplied by a single source and certified flow tests, witnessed by a professional engineer, shall be available.
6. Five-year product warranty and free first-year cartridge exchange, up to 10 percent.

D. Construction:

1. The internal wear surfaces of the valve cartridge shall be stainless steel.
2. The internal flow cartridge body shall have machined threads so the spring free height may be compensated for without the use of fixed shims. A crimped sheet metal design is not acceptable.
3. The internal flow cartridge shall be permanently marked with the GPM and spring range.
4. For ½-inch through 2-inch pipe sizes: An assembly shall consist of a brass Y-type body, integral brass-body ball valve and "O" ring type union; Flow Design Model AC or approved equal.

5. For 2 ½-inches and larger flanged connections: Ductile-iron body suitable for mounting wafer style between standard 150# or 300# flanges. The long flange bolts and nuts shall be provided with each control valve. Flow Design Model WS or approved equal.
6. All valves shall be factory leak tested at 100 psig air under water.

E. Minimum ratings:

1. ½-inch through 2-inch pipe size: 400 PSIG at 250 degrees Fahrenheit.
2. 2 ½ -inch through 14-inch pipe size: 600 PSIG at 250 degrees Fahrenheit.
3. 16-inch through 30 -inch pipe size: 250 PSIG at 250 degrees Fahrenheit.

F. Flow Verification

1. The differential pressure across the Automatic Flow Control Valve shall be measured for flow verification and to determine the amount of system over heading or under pumping.

G. Test Kit:

1. A different pressure test kit shall be supplied to verify flow and measure overheading. The kit shall consist of a 4-1/2 -inch diaphragm gauge equipped with ten-foot hoses and P/T adapters all housed in a vinyl case. Calibration shall be 0 - 35 PSIG for 2 - 32 PSI spring range.

2.5. STRAINERS

A. Strainers shall be of the basket or "Y" type and shall be heavy and durable, constructed of best grade gray iron with the bottoms drilled and plugged. Bodies shall have arrows clearly cast on the sides to show flow direction. Strainers shall be equipped with easily removable covers and brass sediment baskets made of brass not less than #22 gauge in thickness. Total area of basket perforations shall be not less than four times the cross section of the entering pipe. Flow shall be into basket, and then out through the perforations. Strainers shall be suitable for water or the intended fluid. Strainers 2 inches and smaller shall have threaded or solder ends, 2 inches and larger shall have flanged ends.

B. Strainer screens shall be stainless steel with perforations and shall be 1/16-inch for pipe sizes 5 inches and less, 1/8-inch (40 percent open area) perforations for pipe sizes 6-inch and greater.

C. Provide valved and capped (with chain) blowdowns in each strainer. Blowdown valves shall be Appolo 78-100/200 series or as approved equal.

D. Strainers shall be manufactured by Watts, Mueller, Armstrong, Yarway, Spirax/Sarco or as approved equal.

2.6. UNIONS, FLANGES, AND COUPLINGS

A. Unions in steel pipe 2-inches and smaller shall be malleable iron with brass inserted seats designed for a working pressure of 150 psig.

B. Unions in copper pipe 2-inches and smaller shall be sweat fittings with bronze seats designed for a working pressure of 125 psig.

C. Flanges for steel pipe over 2 inches shall be 150 psig, forged steel, slip on. Gaskets shall be 1/16 inch thick pre-formed neoprene.

D. Flanges for copper pipe over 2 inches shall be bronze. Gaskets shall be 1/16 inch thick preformed neoprene.

2.7. MANUAL AIR VENTS

A. Manual air vents shall be similar to the hereinafter specified gauge valves. Provide 1/4-inch size on ¾-inch pipe and smaller, ½ -inch size on 1-inch pipe and larger. Install at all high points of piping. Valves shall be Crane No. 88, or as approved equal, with threaded ends, bronze body, bronze or brass bonnet and bronze stem.

2.8. AUTOMATIC AIR VENTS

A. Provide at air separators, expansion tanks and where shown on the drawings, float actuated non-modulating high capacity air vent to purge free air from the system and provide a positive shut-off at pressures up to 150 psig at a maximum temperature of 250 degrees Fahrenheit. The high capacity air vent shall prevent air from entering the system if the system pressure drops below atmospheric pressure. The air vent shall be pilot operated for intermittent purging of free air up to pressures of 2 psig during normal system operation and diaphragm operated for full capacity purging of free air at pressures between 2 and 150 psig. The high capacity air vent shall be constructed of cast iron and fitted with components of type 313 stainless steel, brass, EPDM and silicone rubber. Pipe discharge to closest floor drains with Type K copper tubing. The high capacity vent shall be Model 107 by Bell and Gossett, Model 13w by Spirax Sarco, Taco, Spirotherm Spirotop, or as approved equal.

2.9. THERMOMETERS

A. Unless otherwise indicated, thermometers shall be ASTM E1, in a glass type, organic filled, 9-inch scale size, corrosion-resistant metal case, with "any-angle" mounting with positive locking device. Trerice Industrial Thermometers, Weksler Instruments, Ernst Gage Co., Miljoco, or approved equal. Insertion stem length shall suite the pipe size and configuration. Thermometer wells shall be brass with brass union hubs in copper and in ferrous piping. Where piping is insulated or otherwise covered, use wells with lagging extension. Where wells are installed in pipe tees at turns, increase pipe size so that well does not restrict flow. Accuracy shall be 2 percent.

B. Unless otherwise indicated, thermometer ranges shall be as follows:

1. Geothermal water systems: 0 degrees F to 100 degrees Fahrenheit, 1 degrees Fahrenheit Division

C. Provide heat conducting compound in wells.

D. At Contractor's option, light powered thermometers may be utilized in lieu of organic filled thermometers.

2.10. PRESSURE GAUGES

A. Unless otherwise indicated, pressure gauges shall be the bronze bourdon tube type, 4-1/2-inch dial, stem mounting, cast aluminum adjustable pointer, 1 percent accuracy over middle half of scale range, 1-1/2 percent over balance: Trerice Model 600C; Weksler Instruments, Ernst Gage Co., Miljoco, or as approved equal.

B. Gauges shall have pressure, vacuum, compound, or retard ranges as required, select ranges so that the normal readings are at the approximate midpoint and maximum system pressures do not exceed full scale.

C. Furnish and install a gauge valve at each pressure gauge. Gauge valves shall be Crane Model No. 88, Needle Valve, Ernst Gage Co. FLG 200, Wexler Instrument Corp. Type BBV4, or approved equal, rated for pressure intended.

D. Gauge connections for pressure gauges, thermometers, or control instruments shall be made using tee fittings, except that gauge connections up to 1-inch size in steel may be using threaded extra heavy pipe couplings welded directly to the main, provided that the main is at least 2-inch size for 2-inch connections, 3-inch size for 3/4-inch connections, and 4-inch size for 1-inch connections. Minimum gauge connection shall be 2-inch ips.

E. Provide snubbers on all gauges. Snubbers shall be No. 872 by Trerice, RS1/RS6 by Wexler Instruments, Miljoco or as approved equal.

2.11. FLOW METERS

A. Flow measuring fittings shall be Accuflow, Bell & Gossett, Flow Design, Inc., Dwyer, or as approved equal. The probe shall sense both the total pressure (upstream) and the static pressure (downstream) and by use of the double averaging design shall maximize the accuracy of the flow measurement. The flow fitting locations shown on the plans are schematic and indicate flows required to be measured. Exact locations shall be such that the straight pipe lengths required by the manufacturers installation instructions be adhered to and the location be accessible. Submittal data shall include a schedule showing flow fitting location, size, and GPM required. Each metering station is to be furnished with a balancing valve and a nameplate permanently attached with a brass chain. The pressure drop for each flow fitting shall not exceed one foot. The combined accuracy of the primary metering element and the readout instrument shall be within plus or minus 2 percent of actual flow. For copper type L in-line stations 1-1/2 inches and less shall have brass fittings with solder connections. For in-line stations of steel or brass 1-1/2 inches and less shall have threaded ends. Standard metering stations shall be utilized for piping 2 inches and greater.

B. A sentinel differential pressure gauge shall be supplied with carrying case and hoses.

Accuracy shall be plus or minus ¾ percent of full span. Connecting hoses shall be 12 feet in length with the terminal fittings to be SAE flare swivel for ease in connection. Additional readout meter shall be furnished for the circuit setters. Differential pressure gauge system shall be Bell and Gossett or as approved equal.

C. At Contractor's option Griswold disturbed flow measurement quickset flow meters may be utilized in lieu of sentinel type flow meters. Units shall consist of a spun steel venturi welded into the pipe. Disturbed fluid shall be channeled through the throat of the venturi with a multi-point Piezo Ring. Accuracy shall be ± 1% PSID with no straight pipe run required. Furnish differential pressure gauge supplied with carrying case and hoses.

D. At Contractor's option Griswold disturbed flow measurement quickset flow meters may be utilized in lieu of sentinel type flow meters. Units shall consist of a spun steel venturi welded into the pipe. Disturbed fluid shall be channeled through the throat of the venturi with a multi-point Piezo Ring. Accuracy shall be ± 1% PSID with no straight pipe run required. Furnish differential pressure gauge supplied with carrying case and hoses.

2.12. PIPING SPECIALTIES

A. Furnish and install flexible pipe connections, as specified and/or shown on the drawings, at suction and discharge connections of all base mounted and vertical in-line pumps, connections to air handlers**,** connections to heat pumps**,** connections to energy recovery ventilators, all vibrating equipment and elsewhere as shown. Pump flexible connections shall be utilized at pumps and hose kits at heat pumps. Refer to Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment* for specifications.

B. Pressure relief valves shall be provided in the number and sizes required to relieve 110 percent of the full input to the systems. Valves shall be rated; and installed in accordance with ASME, and CSD-1 including all amendments. Pipe discharge full size to floor drain, (with union) and support discharge pipe to prevent exerting any strain on relief valve body, piping to be Type-L copper. Water safety relief valves shall be Watts Series 740, Conbraco, Series 154A, Bell and Gossett, or approved equal. Provide pressure gauge adjacent to all safety relief valves.

2.13. ESCUTCHEONS

A. Provide chromium plated escutcheons properly fitted and secured with set screws on all exposed piping which passes through walls, floors or ceilings of finished spaces.

B. All escutcheon plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface. Plastic escutcheon plates will not be accepted.

2.14. DIELECTRIC CONNECTIONS:

A. Furnish and install electrically insulated dielectric unions or flanges, as manufactured by EPCO Sales, Inc., at the following locations:

1. Where steel piping systems join copper piping.

2. Where copper tube connects to domestic water storage tanks, water heaters, heat exchangers, expansion tanks, and other steel vessels.

3. Avoid the installation of steel nipples, cast iron or steel valves and specialties, or other ferrous components in predominately copper piping systems. Where such installation is necessary, isolate the component with dielectric connections. Do not mix steel pipe and copper tube in the same run of pipe or in the same section of a piping system.

2.15. SLEEVES

A. Sleeves shall be provided around all pipes through walls, floors, ceilings, partitions, roof structure members or other building parts. Sleeves shall be standard weight galvanized iron pipe two sizes larger than the pipe or insulation so that pipe or insulation shall pass through masonry or concrete walls or floors. Provide 20 gauge galvanized steel sheet or galvanized pipe sleeves for all piping passing through frame walls.

B. Sleeves through floors shall be flush with the floor except for sleeves passing through Equipment Rooms which shall extend ¾-inch above the floor. Refer to Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment* for mechanical equipment room penetrations additional requirements. Space between the pipe and sleeve shall be caulked. Escutcheon plates shall be constructed to conceal the ends of sleeves. Each trade shall be responsible for drilling existing floors and walls for necessary sleeve holes. Drilling methods and tools shall be as hereinbefore specified.

C. Sleeves through walls and floors shall be sealed with a waterproof caulking compound.

D. Firestop at sleeves that penetrate smoke barriers smoke partitions and/or rated walls/floors.

2.16. PRESSURE REDUCING VALVES

A. Provide pressure reducing valves as indicated, of size and capacity selected by the installer to maintain operating pressure on the system. Body shall be cast-iron or bronze construction, renewable stainless steel seat, non-corrosive disc, water tight cage assembly, adjustable pressure ranges and inlet strainer Watts Regulator Model 223-S, Armstrong, Bell and Gossett or as approved equal.

B. Provide pressure gauge adjacent to all pressure reducing valves to verify proper set point.

2.17. WATER PROOF PIPE PENETRATION SEALS

A. Provide and install waterproof pipe penetration seals at all pipes that enter the building below grade or through exterior wall.

B. Link seals are to be Metraflex Metraseals, Model MS, Linkseal, or approved equal, black

EPDM seal material, glass reinforced plastic pressure plates, zinc plated nuts and bolts, seals are to be resistant to sunlight and ozone, pressure rated to make a hydrostatic seal of up to 20 psig and up to 40 feet of head, temperature rated from –40 degrees F to 250 degrees Fahrenheit.

2.18. TEST PLUGS

A. Description: Nickel-plated, brass-body test plug in NPS 2 (DN15) fitting. Test plugs shall be as manufactured by Trerice, Watts, Natural Meter or approved equal.

B. Body: Length as required to extend beyond insulation.

C. Pressure Rating: 500 psig minimum.

D. Core Inserts: One or two self-sealing valves, suitable for inserting 1/8 inch OD probe from dial-type thermometer or pressure gage.

E. Core Insert: Self-sealing valve, suitable for inserting 1/8 inch OD probe from dial-type thermometer or pressure gage.

F. Core Material for Air, Water, Oil, and Gas: 20 to 300 degrees F chlorosulfonated polyethylene synthetic rubber.

G. Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

H. Test Kit: Pressure gage and adapter with probe, two bimetal dial thermometers, and carrying case.

I. Pressure Gage and Thermometer Ranges: approximately two times the system's operating conditions.

2.19. TRANSITION FITTINGS

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a). Charlotte Pipe and Foundry Company.

b). Harvel Plastics, Inc.
c). Spears Manufacturing Company.

2. Description: PVC or CPVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert and one solvent-cement-socket end.

D. Plastic-to-Metal Transition Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a). Colonial Engineering, Inc.
b). NIBCO INC.
c). Spears Manufacturing Company.

2. Description: PVC or CPVC four-part union. Include brass threaded end, solvent-cement-joint plastic end, rubber O-ring, and union nut.

PART 3. EXECUTION

3.1. GENERAL PIPING INSTALLATION REQUIREMENTS

A. All pipes shall be cut accurately to measurements established at the building, and shall be worked into place without springing or forcing, properly clearing all windows, doors and other openings. Excessive cutting or other weakening of the building structure to facilitate piping installation will not be permitted. All pipes shall be so installed as to permit free expansion and contraction without causing damage. All horizontal mains shall pitch down in the direction of flow with a grade of not less than 1 inch in 40 feet. All open ends of pipe lines, equipment, etc., shall be properly capped or plugged during installation to keep dirt or other foreign material out of the system. All pipes shall be run parallel with the lines of the building and as close to walls, columns and ceilings as may be practical, with proper pitch. All piping shall be arranged so as not to interfere with removal of other equipment on devices not to block access to doors, windows, manholes, or other access openings. Flanges or unions, as applicable for the type of piping specified, shall be provided in the piping at connections to all items of equipment, coils, etc., and installed so that there will be no interference with the installation of the equipment, ducts, etc. All valves and specialties shall be placed to permit easy operation and access and all valves shall be regulated, packed and glands adjusted at the completion of the work before final acceptance. All piping shall be installed so as to avoid air or liquid pockets throughout the work. Ends of pipe shall be reamed so as to remove all burrs.

B. All piping shall be graded to convey entrained air to high points where automatic air vents shall be provided. The size of supply and return pipes for each piece of equipment shall in no case be smaller than the outlets in the equipment.

C. All piping shall be run to provide a minimum clearance of 2-inches between finished covering on such piping and all adjacent work. Group piping wherever practical at common

elevations.

D. All valves, strainers, caps, and other fittings shall be readily accessible.

E. Drain valves with hose connections shall be provided at low points for drainage of piping systems. Blow down valves shall be provided at the ends of all mains and branches so as to properly clean by blowing down the lines throughout in the direction of normal flow.

F. Discharge lines from all relief valves shall be piped to within 4-inches of floor and extend to floor drains wherever floors are not pitched to drains. Pitch the relief valve piping away from the relief valve to issue that no fluid can be trapped in valve discharge. Support all relief valve piping to prevent exerting strain on the relief valve body. The end of the relief valve discharge piping shall not be threaded to prevent capping or plugging.

G. All branches from water mains shall be taken from the top of the supply mains at an angle of forty-five (45) degrees above the horizontal, unless otherwise directed. Branches feeding down shall be taken from the side or bottom of the main on water mains only. All connections shall be carefully made to insure unrestricted circulation, eliminate air pockets or trapped condensate, and permit the complete drainage of the system.

H. Cutoff valves shall be provided on each branch line from the mains on all heating/air conditioning lines.

I. Shut-off valves shall be installed at the inlet and outlet of each coil and piece of equipment to permit isolation for maintenance and repair. Units having multiple coils shall have separate valves for each coil.

J. Balancing valves shall be installed in all heating/air conditioning water branches and at all pumps, and where indicated on the drawings.

K. Unions shall be installed on all bypasses, ahead of all traps, at all connections to equipment, where shown on drawings or where required to facilitate removal of equipment whether shown or not.

L. Spring clamp plates (escutcheons) shall be provided where pipes are exposed in the building and run through walls, floors, or ceilings. Plates shall be chrome plated spun brass of plain pattern, and shall be set tight on the pipe and to the building surface.

M. If the size of any piping is not clearly evident in the drawings, the Contractor shall request instructions for the Engineer as to the proper sizing. Any changes resulting from the Contractor's failure to request clarification shall be at his expense. Where pipe size discrepancies or conflicts exist in the drawings, the larger pipe size shall govern.

N. Install all valves with stem upright or horizontal, not inverted.

O. Where pipe support members are welded to structural building framing, scrape, brush clean, weld and apply one coat of zinc rich primer.

P. Provide clearance for installation of insulation and access to valves and fittings.

Q. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

R. All water containing pipes shall be routed clear of fresh air dampers and louvers to prevent freezing condition when dampers are open.

S. Provide manual air vents at top of piping systems.

3.2. THERMOMETER AND PRESSURE GAGE INSTALLATION REQUIREMENTS.

A. Install thermometers and adjust vertical and tilted positions.

B. Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

1. Install with socket extending to one-third diameter of pipe.
2. Fill sockets with oil or graphite and secure caps.

C. Install pressure gages in piping tees with pressure-gage valve located on a pipe at most readable location.

D. Adjust faces of thermometer and gages to proper angle for best visibility.

E. Clean windows of thermometer and gages and clean factory-finished surfaces. Replace cracked and broken window, and repair scratched and marred surfaces with manufacturer's touch up paint.

3.3. VALVE INSTALLATION REQUIREMENTS

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

G. Install valves as indicated, according to manufacturer's written instructions.

H. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

I. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

J. Locate valves for easy access and provide separate support where necessary.

K. Install valves in horizontal piping with stem at or above the center of the pipe.

L. Install valves in a position to allow full stem movement.

M. For chain-wheel operators, extend chains to 60 inches above finished floor elevation.

N. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

3.4. AUTOFLOW CONTROL VALVE INSTALLATION

A. Install automatic flow control valves on the return lines of coils as indicated on the contract drawings. A balancing valve on supply side is not acceptable.

B. The standard ports and handles shall clear 1-inch thick insulation. Provide handle and port extensions for all insulation over 1-inch thick.

C. Install, on the supply side of coils, a Y-strainer (40 mesh, 2 GPM or less; 20 mesh, above 2 GPM) with brass blow down valve with ¾-inch hose-end connection with cap. Inline (basket) strainer is not acceptable.

D. Where installed in piping with a vapor barrier, field insulate valve body to prevent surface condensation.

3.5. REFRIGERANT PIPING AND ACCESSORIES INSTALLATION REQUIREMENTS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically

indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater tan system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed below ground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
2. Install horizontal suction lines with a uniform slope downward to compressor.
3. Install traps and double risers to entrain oil in vertical runs.
4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves.

R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section, “Common Work Results for HVAC”.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section, “Common Work Results for HVAC”.

T. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section, "Common Work Results for HVAC".

U. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6m) long.
2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6m) or longer.
3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6m) or longer, supported on a trapeze.
4. Spring hangers to support vertical runs.
5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

V. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS ½ (DN 15): Maximum span, 60 inches (1500mm); minimum rod size, ¼ inch (6.4mm).
2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500mm); minimum rod size, ¼ inch (6.4mm).
3. NPS 1 (DN 25): Maximum span, 72 inches (1800mm); minimum rod size, ¼ inch (6.4mm).
4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400mm); minimum rod size, 3/8 inch (9.5mm).
5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400mm); minimum rod size, 3/8 inch (9.5mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400mm); minimum rod size, 3/8 inch (9.5mm).
7. NPS 2-½ (DN 65): Maximum span, 108 inches (2700mm); minimum rod size, 3/8 inch (9.5mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3m); minimum rod size, 3/8 inch (9.5mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7m); minimum rod size, 1/2 inch (13mm).

W. Support multifloor vertical runs at least at each floor.

X. Furnish and install complete refrigerant piping systems between the indoor units and outdoor units. Support piping in accordance with Division 23 Section, *HVAC Piping, Fittings, Valves, Etc.* Piping shall be sized as recommended by unit manufacturer taking into account length of vertical and horizontal runs, and refrigerant type. Provide and install dual sets of refrigerant piping on all units required to have dual independent circuits.

Y. Furnish and install all required piping accessories including, but not limited to, thermal expansion valves, Sporlan, or approved equal; Packless isolation valves at condenser and evaporator coil, Henry or approved equal, charging valve with chained seal cap, Henry or approved equal, sight glasses, Henry or approved equal; filter dryer with replaceable

cartridge, sporland, or approved equal, liquid line solenoid valve l20V/1/60 Hz., Sporlan, or approved equal. Contractor shall provide traps and double suction risers if required by equipment manufacturer. Pitch piping for proper oil return. Submit shop drawings on all components, and piping arrangements.

Z. All accessories shall be ARI rated. Furnish required nitrogen and refrigerant to fully test and charge system. Flood piping system with nitrogen when brazing.

AA. Refrigerant piping shall be Type 1 hard temper (ACR) copper tubing with wrought copper colder fittings. Make joints with silver solder and non-corrosive flux.

BB. Refrigerant piping shall be cleaned, dehydrated and evacuated. Piping shall be evacuated and held to less than 2.5 mm Hg vacuum for a period of not less than 12 hours without appreciable pressure rise. Vacuum shall then be broken with refrigerant or dry nitrogen and re-evacuated to 2.5 mm Hg vacuum for an additional 12 hours. Piping test to be witnessed by Owner's representative and documented in writing. Submit results of tests to Architect/Engineer.

CC. All refrigerant/suction lines sets shall be fully insulated. Exterior pipe insulation shall be fully jacketed as specified in Division 23 Section, *HVAC Insulation*.

DD. Follow ASHRAE 15, latest edition procedures for charging and purging of systems and for disposal of refrigerant.

EE. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

FF. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

GG. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

HH. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

II. Fully charge completed system with refrigerant after tested.

JJ. Provide electrical connection to solenoid valves.

KK. Install liquid indicators in liquid line leaving condenser, in liquid line leaving, and on leaving side of liquid solenoid valves.

LL. Install strainers immediately upstream from each automatic valve, including expansion valves, solenoid valves, hot-gas bypass valves, and compressor suction valves.

MM. Install strainers in main liquid line where multiple expansion valves with integral strainers are used.

NN. Install strainers in suction line of steel pipe.

OO. Install moisture-liquid indicators in liquid lines between filter-dryers and thermostatic

expansion valves and in liquid line to receiver.

PP. Install flexible connectors at or near compressors where piping configuration does not absorb vibration.

QQ. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.

1. Test refrigerant piping, specialties. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.

    a). System shall maintain test pressure at the manifold gage throughout duration of test.
    b). Test joints and fittings by brushing a small amount of soap and glycerin solution over joint.
    c). Fill system with nitrogen to raise a test pressure of 150 psig (1035 kPa) or higher as required by authorities having jurisdiction.
    d). Remake leaking joints using new materials, and retest until satisfactory results are achieved.

RR. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

SS. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

TT. Adjust set-point temperature of the conditioned air or chilled-water controllers to the system design temperature.

UU. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Check compressor oil level above center of sight glass.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves, except bypass valves that are used for other purposes.
5. Check compressor-motor alignment, and lubricate motors and bearings.

VV. Before installing copper tubing other than Type ACR, clean tubing and fittings with trichloroethylene.

WW. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

XX. Charge system using the following procedures:

1. Install core in filter-dryer after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).

4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

3.6. PIPE JOINTS INSTALLATION REQUIREMENTS

A. Welded Joints: Joints in piping 2-1/2-inches and larger shall be fusion welded. Welding shall be in accordance with recommendations of the American Welding Society. Welding fittings shall conform in physical and chemical properties to the latest revisions of the American Society for Testing Materials.

B. Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9 as applicable, for shop and project site welding of piping work. Certify welding of piping work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB). Submit welders qualifications for approval.

C. Screwed Joints: All screwed joints shall be made with tapered threads properly cut. Screwed joints shall be made perfectly tight with a stiff mixture of graphite and oil, applied with a brush to the male threads on the fittings.

D. Soldered Joints and Copper Piping: Joints in copper piping shall conform to the following minimum standards.

1. The pipes shall be cut to a length making certain that the ends are square, using a fins hacksaw blade or tube cutter. The ends of all pipes shall be reamed and all burrs removed.
2. The outside end of the pipe and the cut end of the fitting shall be cleaned with steel wool, sand cloth, or steel wire brush. All dark spots shall be removed.
3. The flux shall be applied evenly and sparingly to the outside end of the pipe and the inside of the outer end of the fitting until all surfaces to be jointed are completely covered. The piping and fitting shall be slipped together and reworked several times to insure an even distribution of the flux.
4. The correct amount of solder per joint for each size pipe shall be used in accordance with the manufacturer's recommendations.
5. Solder joints shall be made by using a direct flame from a torch.
6. On pipe sizes larger than ¼-inch, the fittings and valves in the pipe shall be moved or tapped with a hammer when the solder starts to melt to insure an even distribution of the solder.
7. The excess solder shall be removed while it is still in the plastic state leaving a fillet around the cup of the fitting.
8. Solder joints shall be suitable for working pressure of 100 psig and for working temperature of not less than 250 degrees F. The type of solder and flux used will be submitted for approval. Type 95-5 shall be the minimum standard.
9. Lead and antimony-based solders shall not be used for potable water systems. Brazing and silver solders are acceptable.

E. Where copper piping joins steel piping, approved bronze adapters shall be used.

F. Prohibited Connections: No direct weld, soldered, or brazed connections, without unions or

flanges, shall be made to valves, strainers, apparatus, or related equipment. Right and left couplings, long threads, or caulking of pipe threads or gasket joints will not be permitted.

3.7. HANGERS, SUPPORTS, ANCHORS, GUIDES INSTALLATION REQUIREMENTS

A. General: All hangers shall be of an approved type arranged to maintain the required grading and pitching of lines to prevent vibration and to provide for expansion and contraction. Provide protection saddles between hangers and insulation on heating water insulated pipe. Saddles shall be Grinnells Figure 173/273 or approved equal. Provide approved spacers between saddles and pipe where flexible insulation is specified. Provide insulation protection shields for insulated piping without saddles. Shield shall be Grinnell Figure 167 or as approved equal.

B. Spacing: Regardless of spacing, hangers shall be provided at or near all changes in direction, both vertical and horizontal, for all piping. For cast iron soil pipe, one hanger shall be placed at each hub or bell.

C. Vertical Lines: Shall be supported at their bases, using either a suitable hanger placed in a horizontal line near the riser, or a base type fitting set on a pedestal, foundation or support. All vertical lines extending through more than one floor level shall be supported at each floor with a riser clamp. Riser clamp shall be Grinnell Co.'s Figure 261, or approved equal. All vertical drops to pump suction elbows shall be supported by floor posts.

D. Racks and Brackets: All horizontal piping on vertical walls shall be properly supported by suitable racks securely anchored into the wall construction. Where not practical to obtain ceiling anchorage, all piping near walls shall be supported by approved brackets securely anchored into the wall construction. Washer plates (Fib. 60, 60L) and other miscellaneous attachments, fasteners, etc., shall be Grinnell or as approved equal. All exterior hanger and bracket systems in their entirety shall be galvanized.

E. Pipe Hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer.

F. Select hangers and components for loads imposed. Secure rods with double nuts.

G. Support of horizontal piping shall allow for vertical adjustment after installation of piping.

H. Support overhead piping with clevis hangers.

I. Do not support all parallel piping from the same joist. Stagger all supports in accordance with the structural engineer's recommendations.

J. Install guides on piping adjoining expansion fittings and loops.

K. Attach guides to pipe and secure to building structure.

L. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.

M. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

N. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

O. Install pipe anchors according to expansion fitting manufacturer's written instructions if expansion fittings are indicated.

P. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

Q. Refer to structural documents for appropriate connection/attachment materials to building.

3.8. AIR VENTING INSTALLATION

A. The top of each hydronic water supply and return piping and other points as indicated or where necessary for the removal of air from the system or equipment, shall be vented using an approved type of manual air vent.

B. In addition to manual air vents at high points of system, each item of water heat transfer equipment shall be manually vented using an approved type manual air vent. All air vents shall be accessible.

3.9. EXPANSION LOOPS AND SWING CONNECTION INSTALLATION REQUIREMENTS

A. Install expansion fittings according to manufacturer's written instructions.

B. Install expansion fittings in sizes matching pipe size in which they are installed.

C. Align expansion fittings to avoid end-loading and torsional stress.

D. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

E. Attach pipe bends and loops to anchors.

1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

F. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

G. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

H. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.10. PIPING IDENTIFICATION INSTALLATION

A. All piping shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color code and system identification shall comply with ANSI Standards and piping identification system shall comply with ASME A13.1-81., scheme for the identification of piping systems and ASHRAE Fundamentals Handbook, latest edition.

B. Markings shall be plain block letters, stenciled on pipes, and shall be located near each branch connection, near each valve, and at least every 10 feet on straight runs of pipe. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such manner as to be easily legible from the floor. Pipe identification schedule shall be as follows:

OUTSIDE DIAMETER OF PIPE OR COVERING (INCHES)	LENGTH OF COLOR FIELD (INCHES)	SIZE OF LETTERS (INCHES)
½ to 1 ¼	8	½
1-½ to 2	8	¾
2 ½ to 6	12	1 ¼
8 to 10	24	2 ½
Over 10	32	3 ½

3.11. VALVE IDENTIFICATION

A. All valves shall be tagged with a numbered tag.

B. The tags shall be made of 1-inch diameter brass tags fastened to the valve by means of brass chains. Numbers shall agree with valve numbers on diagrammatic herein before specified.

C. Provide a minimum of six (6) valve charts with valve numbers indicating valve type, size, manufacturer and service.

D. Additional valve charts shall be mounted behind glazed wooden frames and be hung in each mechanical equipment room including each air handling unit mechanical equipment room. Additional copies shall be provided in each copy of the O&M manuals.

3.12. CLEANING PIPING AND EQUIPMENT

A. All condensate, HVAC, and geothermal systems shall be cleaned by filling with a solution of

one (1) pound of trisodium phosphate to each 50 gallons of water and circulating this solution for a period of six (6) hours during which time the system shall reach operating temperature. The systems shall then be flushed with fresh water and refilled with fresh water and/or where indicated antifreeze solution and purged of all air.

B. All condensate, HVAC, geothermal, piping system shall be flushed clean with fresh water. See Division 22 Sections, *Plumbing Fixtures* and *Plumbing Equipment* for domestic potable water cleaning and sterilization. Where indicated, hydronic systems shall be filled with 25 percent by volume antifreeze.

C. Any equipment, such as coils that have small tubing, shall be bypassed to prevent deposition of debris from the piping. Water balancing shall not be scheduled until the completion of the cleaning and treatment process.

END OF SECTION

DIVISION 23 SECTION 230548
VIBRATION CONTROLS FOR HVAC, PLUMBING AND FIRE PROTECTION EQUIPMENT

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EQUIPMENT

PART 1 RELATED DOCUMENTS

1.1 RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 GENERAL

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and Division 0I Specification Sections apply to work of this section.

B. All work under this section shall also be subject to the requirements of Division 23 Section, *Common Work Results for HVAC*.

1.3 SUMMARY

A. Provide all labor and materials necessary to furnish and install vibration control systems on this project as herein specified and/or shown on the drawings.

B. Mount all mechanical equipment on suitable vibration isolators so as to prevent transmission of vibration into or through the building structure. Isolators shall be as manufactured by Mason Industries, Inc., Korfund, Inc., Amber Booth, or approved equal, and shall be selected by the isolator manufacturer for each item of equipment in accordance with requirements hereinafter specified.

C. The equipment manufacturer shall supply all pump and motor bases, fan and motor bases, cradles, isolation pipe/duct hangers, spring and/or neoprene isolators, neoprene pads, flexible connectors, etc. as a coordinated package by a single manufacturer.

D. Select isolators for uniform static deflections according to distribution of weight; and for not less than the indicated isolation efficiency with the lowest rotational speed of equipment as the disturbing frequency.

E. Isolators and bases shall be stable during stopping and starting of equipment without transverse or eccentric movement of equipment, and shall be designed to resist horizontal forces of equipment which may operate unbalanced.

F. In general, select isolators on the basis of criteria as specified in the ASHRAE Applications Handbook, Latest Edition.

1.4 SUBMITTALS

A. Shop Drawings: Indicate and locate vibration isolators, with static and dynamic load on each.

B. Product Data: Provide schedule of vibration isolator type with location and load on each.

C. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

D. Manufacturer's Certificate: Certify that isolators are properly installed and adjusted to meet or exceed specified requirements.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 PROJECT RECORD DOCUMENTS

A. Record actual locations of hangers including attachment points.

1.6 COLOR CODING

A. All springs shall be color coded for load carrying capacity.

1.7 ALTERNATES

A. Refer to Division 01 Section, *Alternates* - Alternates for description of work under this section affected by alternates.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Isolators shall be the equivalent of the following types by Mason Industries, Inc., Korfund, Inc. or approved equal.

2.2 CORROSION PROTECTION FOR STEEL PARTS

A. Where steel parts are exposed to weather or humid environments provide hot-dipped galvanized coating of at least 2 ounces of zinc per square foot of surface. Coat springs with neoprene.

2.3 SPRING MOUNTS AND SOUND PADS

A. Provide all spring mounts with leveling devices, minimum .25 inch thick neoprene sound pads, and zinc chromate plated hardware.

B. All sound pads shall be size for minimum deflection of .05 inch; meet requirements for neoprene pad isolators.

2.4 SPRINGS

A. All springs shall have minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between .3 and .6 of maximum deflection.

2.5 NEOPRENE

A. Grade durometer 40, 50 OR 60 AND OIL RESISTANT.

2.6 FLOOR MOUNTED ISOLATORS:

A. Neoprene Isolation Pads: Provide pads at least ¼ " thick with cross-ribbed or waffle design. For concentrated loads provide steel bearing plates bonded or cold cemented to the pads. Neoprene isolation pads shall be Type Super W.

B. Neoprene Isolators: Rubber (neoprene)-in-shear mounting: Provide molded neoprene isolators having steel base plates with mounting holes and, at the top, steel mounting plates with mounting holes or threaded inserts. Provide elements of type and size coded with molded letters or color-coded for capacity identification. Embed metal parts completely in neoprene. Double deflection neoprene mountings shall have a minimum static deflection of 0.35". Bolt holes shall be provided for these areas where bolting is required. On equipment such as small vent sets and close coupled pumps, steel rails shall be used above the mounting to compensate for the over-hang. Mountings shall be type ND or rails type DNR.

2.7 SPRING ISOLATORS

A. General: Provide spring isolators or protected spring isolators that are adjustable and laterally stable with free-standing springs of horizontal stiffness at minimum 80 percent of the vertical (axial) stiffness. For machine-attached and floor-attached restraining elements, separate from metal-to-metal contact by neoprene cushions 1/8 inch thick minimum. Provide neoprene acoustic friction pads at least ¼ inch thick.

B. Spring Isolator: Spring type isolators shall be free standing and laterally stable without any housing and complete with ¼ " neoprene acoustical friction pads between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflections, compressed spring height and solid spring height. Mountings shall be type SLF as manufactured by Mason Industries, Inc. or as approved equal.

2.8 SUSPENSION ISOLATORS

A. General: Provide hangers with suspension isolators encased in open steel brackets. Isolate hanger rods from isolator steel brackets with neoprene-lined opening.

B. Suspension Neoprene Isolators: Provide double-deflection elements with minimum 3/8 inch deflection.

C. Suspension Spring Isolators: Vibration hangers shall contain a steel spring and 0.3" deflection neoprene element in series. The neoprene element shall be molded with a rod isolation bushing that passes through the hanger box. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30^{o} arc before contacting the hole and short circuiting the spring. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include a scale drawing of the hanger showing the 30^{o} capability. Hangers shall be type 30N.

D. Precompressed Suspension Spring Isolators: Vibration hangers shall be as described in "C" above, but they shall be precompressed to the rated deflection so as to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a scale drawing of the hanger showing the 30^{o} capability. Hangers shall be type PC30N.

E. Ductwork Suspension Spring Isolators: Vibration hangers shall contain a steel spring located in a neoprene cup manufactured with a grommet to prevent short circuiting of the hanger rod. The cup shall contain a steel washer designed to properly distribute the load on the neoprene and prevent its extrusion. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing thru a 30^{o} arc before contacting the hole and short circuiting the spring. Spring shall have a minimum additional travel to solid equal to 50% of the rated deflection. Hangers shall be provided with an eye bolt on the spring end and provision to attach the housing to the flat iron duct straps. Submittals shall include a scale drawing of the hanger showing the 30^{o} capability. Hangers shall be type W30.

2.9 THRUST RESTRAINTS

A. Adjustable spring thrust restraints, able to resist the thrust force with at least 25 percent unused capacity. The operating spring deflection shall be not less than 50 percent of the static deflection of the isolation supporting the machinery. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow

for a maximum of ¼" movement at start and stop. The assembly shall be furnished with one rod and angle bracket for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit. Horizontal thrust restraints shall be type WB.

2.10 FLEXIBLE CONNECTORS FOR PIPING

A. General: Straight or elbow flexible connectors rated for temperatures, pressures, and fluids to be conveyed. Provide flexible connectors with the strength 4 times operating pressure at highest system operating temperature. Provide elbow flexible connectors with a permanently set angle.

B. Elastomeric Flexible Connectors: Flexible neoprene connectors shall be manufactured of multiple plys of nylon tire cord fabric and neoprene both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement. Straight connectors shall have two spheres. Connectors up to and including 1 ½ " diameter may have threaded ends. Connectors 2" and larger shall be manufactured with floating galvanized flanges recessed to lock the connector's raised face neoprene flanges. Hoses shall be installed on the equipment side of the shut-off valves. Connectors shall be rated a minimum of 150 psi at 220^{o}F. Flanged equipment shall be directly connected to neoprene elbows in the size range 2 ½ " through 12" if the piping makes a 90^{o} turn at the equipment. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer to prevent additional elongation under pressure. 12" and larger sizes operating above 100 psi shall employ control cables with end fittings isolated by means of ½ " thick bridge bearing neoprene washer bushings designed for a maximum of 1000 psi.

Submittals shall include two test reports by independent consultants showing minimum reductions of 20 DB in vibration accelerations and 10 DB in sound pressure levels at typical blade passage frequencies.

Elbows shall be Mason-Flex type MFNEC, straight connectors Mason-Flex type MFTFU or MFTNC, and control cable assemblies type ACC.

C. Metal Flexible Connectors: Fabricated of Grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless steel braid restraining and pressure cover. Sizes 3" and larger shall be flanged. Sizes 2 ½ " and smaller shall have male nipples. Lengths shall be as indicated:

Nominal Diameter (Inches)	Length (Inches)
½ "	12"
3/4"	12"
1 ½ "	12"
1 ½ "	12"

2"	12"
2 ½ "	12"
3"	18"
4"	18"
5"	24"
6"	24"
8"	24"
10"	24"
12"	36"
14"	36"
16"	36"

Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be type BSS.

2.11 NEOPRENE PAD ISOLATORS

A. Rubber or neoprene waffle pads.

1. 30 durometer
2. Minimum 2 inch (13mm) thick
3. Maximum loading 40 psi (275 kPa)
4. Height of ribs shall not exceed 0.7 times width.

B. Configuration: ½ inch (13mm) thick waffle pads bonded each side of ¼ inch (6 mm) thick steel plate.

2.12 RUBBER MOUNTS

A. Molded rubber designed for 0.6 inches (13 mm) deflection with threaded insert.

2.13 GLASS FIBER PADS

A. Neoprene jacketed pre-compressed molded glass fiber.

PART 3 EXECUTION

3.1 GENERAL PROVISIONS

A. Install vibration-and-noise isolation materials and equipment as indicated and in accordance with machinery manufacturer's instructions.

B. Where neoprene elements of vibration isolator may be subjected to high pipe temperatures above 160^{o}F, provide metal heat shields or thermal isolators.

C. A minimum of 4" thick reinforced concrete housekeeping pads shall be provided under all floor mounted equipment. Rest subbases on structural floor and reinforce with steel rods interconnected with floor reinforcing bars by tie bars hooked at both ends. Provide at least one (1) inch clearance between subbases and inertia bases, steel bases, and steel saddles with machinery in operation.

D. All vibration isolators exposed to weather or humid environment shall be hot dipped galvanized with springs coated with neoprene in accordance with paragraph hereinbefore described.

E. Anchor Bolts and Grout: Secure machinery to foundations with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.

F. Common Machinery Foundations: Mount electrical motors on the same foundations as driven machinery. Support piping connections, strainers, valves, and risers on the same foundation as the pumps.

G. Vertical Stops: For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.

H. Thrust Restraints: Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.

I. Machinery: Provide vibration isolators, flexible connectors and seismic snubbers in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.

J. Stability: Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or adversely affect the machinery or attachments.

K. Lateral Motion: The installed vibration isolation systems for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than ¼ -inch. Restrain motions in excess by approved spring mountings.

L. Unbalanced Machinery: Provide foundation suspension systems specifically designed to resist

horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.

M. Nonrotating Machinery: Mount nonrotating machinery in systems which includes rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.

N. Vibration isolation ceiling hangers shall be installed so that the hanger rods do not touch the sides of the isolator housing, thereby seriously degrading the vibration isolation performance. Vibration isolation ceiling hangers shall be located so that the hanger housing may rotate 360^{o} without touching any object.

O. Electrical Connections: Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit 2 inch minimum displacement in any direction without damage.

P. Systems Not To Be Vibration Isolated: Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.

Q. Install in accordance with manufacturer’s instructions.

R. Install isolation for motor driven equipment.

S. Install spring hangers without binding.

T. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

U. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.

V. Connect wiring to isolated equipment with flexible hanging loop.

3.2 PIPE ISOLATION

A. Horizontal Pipe Isolation:

1. Precompressed Suspension Spring Isolators:

a. For the first three pipe hangers in the main lines near the mechanical equipment provide precompressed suspension spring isolators. Floor supported piping shall rest on trained spring isolators. All precompressed suspension spring isolators hangers or the first three trained spring isolators mounts as noted above, will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75"

deflection for pipe sizes up to and including 3", 1.5" deflection for pipe sizes up to and including 6" and 2.5" deflection thereafter. All other hangers and mounts will have a minimum steel spring deflection of 0.75". Hangers shall be located as close to the overhead supports as practical.

2. Combination Spring and Neoprene Suspension Hanger:

   a. For horizontal runs in other than those hereinbefore specified provide suspension spring hangers (combination spring and neoprene) with .75" minimum steel spring deflection.
   b. Geothermal Interior Heat Pump Piping:

      1). For the first 20 feet of the branch connection of the main supply and return piping at each floor.
      2). For all piping over 2" diameter.

B. Floor-Supported Piping:

1. Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators as described hereinbefore and selected to the guidelines of hangers.
2. The first three adjacent floor supports shall be the restrained spring type with a blocking feature that prevents load transfer to equipment flanges as the piping is filled and drained.
3. Where piping is subject to larger thermal movement a slide plate shall be installed on the top of the isolator. Slide plate shall be teflon, graphite or steel.
4. Provide a thermal barrier where neoprene products are installed directly beneath steam or hot water lines.

C. Pipe Risers: Provide pipe riser supports with bearing plates and two layers of ¼ " thick ribbed or waffled neoprene pad loaded to not more than 50 psi. Separate isolation pads with ¼ " steel plate. Weld pipe riser clamps at anchor points to the pipe and to pairs of vertical acoustical pipe anchor mountings which shall be rigidly fastened to the steel framing.

D. Supports at Base of Pipe Risers: Piping isolation supports at the base of risers shall be two layers of ½" thick heavy-duty neoprene pad separated by ¼ " thick steel plate. Use bearing plates sized to provide a pad loading of not more than 500 psi. Weld the stanchion between the pipe and isolation support to the pipe and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support piping, provide a maximum deflection of 0.08 inches at the mid-span of this steel under the load. Rigidly support piping from the supplementary steel with the supplementary steel isolated from the building structure with isolators.

E. Pipe Anchors: Attach each end of the pipe anchor to an omni-directional pipe isolator which in turn shall be rigidly fastened to the steel framing or structural concrete. Provide a telescoping pipe isolator of two sizes of steel tubing separated by a minimum ½ " thick pad of heavy-duty neoprene or heavy-duty neoprene and canvas. Provide vertical restraints by similar material to prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.3 MECHANICAL, FAN AND EQUIPMENT ROOM SOUND ISOLATION

A. Do not allow direct contact between pipes or ducts and walls, floor slabs, roofs, ceilings or partitions of equipment rooms.

B. Pipe Penetrations: All piping passing through mechanical equipment room and fan room walls, floors and ceilings shall be protected against sound leakage by means of an acoustical wall seal as described hereinbefore and fire stopping.

C. Duct Penetrations: Provide with sound insulation equal to the sound attenuation value of the wall, floor, or ceiling penetrated.

3.4 FLEXIBLE PIPE CONNECTORS

A. Provide flexible connectors in accordance with manufacturers instructions where piping systems serving vibration isolated equipment and as shown on the drawings. Flexible connectors shall be installed near the connection to the equipment. Where liquid pulsation dampening is required, flexible connectors with spherical configuration may be used. Provide restraints for pipe connectors at pumps to prevent connector failure upon pump start-up.

3.5 ISOLATION FOR SPECIFIC EQUIPMENT

A. The vibration isolator manufacture shall provide isolators for all pieces of equipment provided for the job. Isolator shall be selected by the isolator manufacturer on the basis of criteria as specified in the ASHRAE Applications Handbook, latest edition, unless a more stringent requirement is indicated on the drawings.

B. Pumps:

1. All base mounted pumps shall be mounted on concrete housekeeping pads.
2. Floor support of the initial pipe elbows at the pump discharge and suction diffuser at the pump intake shall be made from the isolated inertia base, not from the equipment room floor. Mason Industries Type K or as approved equal.
3. Provide flexible pipe connections at pump suction and discharge. Mason Industries Type BSS or MFTNC/MFTFU with control rods type ACC or as approved equal.
4. Provide discharge and suction vibration isolators at all vertical in-line pumps.

C. Ductless Units: Indoor ductless units shall be supported with rubber grommet type suspension isolators. Compressor units shall be supported on ribbed neoprene pads resting on concrete pad.

3.6 MANUFACTURER'S FIELD SERVICES

A. Inspect isolated equipment after installation and submit report. Include static deflections.

END OF SECTION

DIVISION 23 SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC AND PLUMBING

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SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC AND PLUMBING

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. GENERAL

A. This section covers performance testing, adjusting and balancing of heating, ventilating, air conditioning and domestic re-circulating systems as specified in Division 23 Section, *Heating, Ventilating, and Air Conditioning Equipment* and in Division 22 Section, *Plumbing Fixtures and Plumbing Equipment.*

B. For *Common Work Results of HVAC,* See Division 23. See Division 01 for *General Requirements.*

C. The mechanical contractor shall select and employ an impartial, independent balancing agency to provide testing and balancing services for the heating, ventilating and air conditioning (HVAC) systems and other specified systems of this project.

D. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC and plumbing systems, as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results.

E. The items requiring testing, adjusting, and balancing include, but are not limited to, the following:

Air Systems:
Coils (Air Temperatures & Static Pressure Drops)
Diffusers, Registers and Grilles
Ductless Split System Units
Energy Recovery Ventilators
Exhaust Fans
Geothermal Heat Pumps
Heat Pumps
Supply Fan AHU
Variable Refrigerant Volume Systems and Equipment
Ventilation Fans
Zone Branch and Main Ducts

Hydronic Systems:
Coils
Condensate Pumps
Domestic Hot Water Heater Pumps
Domestic Re-circulating Systems and Water Heater
Energy Recovery Ventilators
Flow Measuring Stations
Geothermal U-Tubes and Headers
Geothermal Heat Pumps
Ground Heat Exchangers
High/Low Mixing Valves (Domestic Water)
In-line Pumps
Pumps
System Mains and Branches
Thermostatic Mixing Valves (Domestic Water)
Thermal Solar System and Pumps
Variable Refrigerant Volume Water Cooled Units

1.3. EXAMINATION

A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:

1. Systems are started and operating in a safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Fire dampers, smoke damper and volume dampers are in place and open.
8. Air coil fins are cleaned and combed.
9. Access doors are closed and duct end caps are in place.
10. Air outlets are installed and connected.
11. Duct system leakage is minimized.
12. Hydronic systems are flushed, filled, and vented.

13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.

C. Beginning of work means acceptance of exiting conditions.

1.4. QUALIFICATIONS OF THE BALANCE AGENCY

A. The balancing agency shall be a member of the Associated Air Balance Council (AABC) and have an engineer certified by the National Examining Board.

B. The certified test and balance engineer shall be responsible for supervision and certification for the total work herein specified.

C. All final reports shall be signed and officially stamped by the certified test and balance engineer.

1.5. PRE-BALANCING CONFERENCE

A. Convene a conference one week prior to commencing work of this Section with all appropriate individuals.

1.6. STANDARDS

A. The balancing agency shall perform the services specified herein in accordance with the Associated Air Balance Council's National Standards, including revisions, to the date of the contract.

B. All terms in this specification shall have their meaning defined as stated in the National Standards.

C. ADC: Test Code for grills, registers, and diffusers.

D. ASHRAE III: Practice for measurement, testing, adjusting and balancing of building heating, ventilation, air conditioning, and refrigeration systems.

E. NEBB: Procedure standards for testing, adjusting, and balancing of environmental systems.

F. SMACNA: HVAC systems testing, adjusting, and balancing.

1.7. COORDINATION

A. It will be necessary for the balancing agency to perform its services in close coordination with the mechanical contractor.

B. The plans and specifications have indicated meters, valves, dampers, and other devices for the purpose of adjusting the system to obtain optimum operating conditions. It will be the responsibility of the mechanical contractor to install these devices in a manner that will leave them accessible and readily adjustable. The balancing agency shall provide guidance if there is a questionable arrangement of a control or balancing device.

C. The general contractor, mechanical contractor, temperature control contractor and suppliers of the HVAC equipment shall all cooperate with the balancing agency to provide all necessary data on the design and proper application of the system components.

D. For heat pumps, the manufacturer's start-up agency and Test and Balance Engineer shall assist each other with obtaining proper flow rates and refrigerant pressures.

1.8. INSTALLATION TOLERANCE

A. Unless otherwise indicated, all air devices shall be adjusted to within plus or minus 10 percent of design. All fans shall be adjusted to within plus or minus 5 percent of design. All pumps and Hydronic equipment shall be adjusted to within plus or minus 5 percent of design.

1.9. RESPONSIBILITIES OF THE MECHANICAL CONTRACTOR

A. The mechanical contractor shall sufficiently complete the installation and start all HVAC systems to insure they are working properly and shall perform all other items as described hereinafter to assist the balancing agency in performing the testing and balancing of the HVAC system.

B. Record equipment manufacturer's standard start-up information and submit to Engineer for review. Testing and balancing work shall not commence on any equipment until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

C. Air Distribution Systems

1. Verify installation for conformity to design.
2. Terminate all supply, return, outside air, exhaust air, relief air, ventilation air ducts, and pressure test them for leakage. Test pressure and leakage rate shall be as specified in Division 23 Section, *HVAC Air Distribution System* under Leakage Tests. Pressure testing shall be performed by mechanical contractor and witnessed by Test and Balance Engineer.
3. Ensure that all splitters, extractors, volume, fire dampers, and smoke damper are properly located and functional. Dampers serving requirements of minimum and maximum outside - return - relief, and exhaust air shall provide tight closure and full opening, with a smooth and free operation.

4. Verify that all supply - return - exhaust and transfer grilles; registers, and diffusers are installed and operational.
5. Ensure that air-handling systems, units, and associated apparatus, such as heating and cooling coils, filter sections, access doors, etc., are blanked and/or sealed to eliminate excessive bypass or leakage of air.
6. Ensure that all fans are operating and free of vibration. All fans and drives shall be checked for proper fan rotation and belt tension. Overload protection shall be of proper size and rating. A record of motor current and voltage shall be made to verify that the motors do not exceed nameplate rating. Record thermal overload ratings for all motors in the Test and Balance Report.
7. Make any necessary changes to the sheaves, belts, and dampers, as required by the balancing agency, at no additional cost to the owner.
8. Install clean filters.
9. For heat pumps, provide refrigerant suction and discharge pressure to Test and Balance Engineer for inclusion in the final TAB Report.

D. Water Circulating Systems

1. Verify installation for conformity to design.
2. Check all pumps to verify pump alignment and rotation.
3. Ensure that systems are clean, with the proper strainer screens installed for normal operation.
4. Check all pump motors for current and voltage, to ensure that motors do not exceed nameplate rating.
5. Provide thermal overload protection of proper size and rating. Record thermal overload ratings for all motors. Insert data in Test and Balance Report.
6. Ensure that all water circulating systems shall be full and free of air; that expansion tanks are set for proper water level; and that all air vents were installed at high points of systems and are operating.

1.10. RESPONSIBILITIES OF THE TEMPERATURE CONTROL CONTRACTOR

A. The temperature control contractor shall complete the installation of the temperature control system, and operate and test all control systems to ensure they are functioning properly as designed. The temperature control contractor shall assist the balancing agency in testing and balancing the HVAC systems, as described hereinafter.

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, freeze stats and duct smoke detectors.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.
3. Calibrate temperature sensors after installation, and before the temperature sensors control verification tests are performed. The balancing agency shall prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditional space for each separately controlled zone.
4. The temperature control contractor shall allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static

pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.

B. All control sequences, software, equipment, and components shall be started-up by a qualified technician. Start-up report shall be submitted to Engineer prior to the commencement of testing and balancing work. Testing and balancing shall not commence until start-up reports are completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

1.11. NOTIFICATION FOR TESTING AND BALANCING WORK TO BEGIN

A. The mechanical contractor shall notify the balancing agency in writing when all heating, ventilating, and air conditioning systems are complete and ready for testing and balancing. The mechanical contractor shall attest that he has completed all items as herein described.

1.12. DEFICIENCIES

A. Any deficiencies in the installation or performance of a system or component observed by the TAB agency shall be brought to the attention of the appropriate responsible person.

B. The work necessary to correct items on the deficiency listing shall be performed and verified by the affected Contractor before the TAB Agency returns to retest. Unresolved deficiencies shall be noted in the final report.

1.13. ADJUSTING

A. Ensure recorded data represents actual measured observed conditions.

B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring all sensors to specified settings.

E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

F. Check and adjust systems approximately six months after final acceptance and submit report.

1.14. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

PART 2. PRODUCTS (NOT APPLICABLE)

PART 3. EXECUTION

3.1. GENERAL

A. Perform all testing and balancing in complete accordance with AABC National Standards for Field Measurements and Instrumentation.

B. Furnish all test instruments and equipment. All instruments must have been calibrated within six (6) months prior to use and shall be checked for accuracy prior to and during the work.

C. Review all systems designs and equipment, manufacturers' data, and be completely familiar with the work before proceeding.

D. Report all malfunctions or deficiencies to the contractor so that corrective action can be taken. Test and Balance Report shall not be submitted for review until all malfunctions or deficiencies are corrected. Repeat tests where required until design conditions are achieved.

E. Where systems or equipment cannot be balanced or adjusted to design conditions, determine the cause and submit a complete report to the Engineer.

F. Retest or rebalance the system as required during the warranty period.

G. Test and balance all systems under adequate load condition. If, in the opinion of the Engineer, there is insufficient load to properly test and balance the systems, perform sufficient preliminary balancing and adjustment to permit operation of the systems until such time as final testing and balancing can be done. Provide in writing the future date when systems shall be tested under sufficient load.

H. At project completion provide a complete set of ½ scale drawings indicating the locations of all ductwork.

3.2. EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

B. Examine systems for installed balancing devices, such as test ports, gage cocks,

thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.

C. Examine the approved submittals for HVAC systems and equipment.

D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems – Duct Design". Compare results with the design data and installed conditions.

G. Examine system and equipment installations and verify that field quality-control testing, cleaning and adjusting specified in individual Sections have been performed.

H. Examine test reports specified in individual system and equipment Sections.

I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

J. Examine terminal units, and verify that they are accessible and their controls are connected and functioning.

K. Examine strainers. Verify that startup screens are replaced by permanent screens and indicated perforations.

L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

M. Examine system pumps to ensure absence of entrained air in the suction piping.

N. Examine operating safety interlocks and controls on HVAC equipment.

O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3. AIR SYSTEM PROCEDURES

A. The balancing agency shall perform the following testing and balancing functions in accordance with the Associated Air Balance Council's National Standards:

1. Fan Speeds - Test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Measure and record motor current and voltage. Check and record thermal overload ratings for all motors.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply, return and exhaust ducts to obtain total CFM. If a Pitot-tube traverse is not practical, the summation of the outlets or inlets may be used. An explanation why a traverse was not made must appear on the appropriate data sheet.
4. Outside Air - Test and adjust system minimum outside air by Pitot-tube traverse. If a Pitot-tube traverse is not practical, the percentage of outside air may be determined by calculations from the return air, outside air, and mixed air temperatures. Make allowances for heat of compression and motor heat where applicable.
5. Static Pressure - Test and record system static pressures, including suction and discharge static pressure of each fan. Record hood static pressure at canopy hoods, fume hoods and similar equipment. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make fan RPM allowances for 50 percent loading of filters.
6. Air Temperature - Take wet-bulb and dry-bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.
7. Zone Ducts - Adjust zone ducts to within design CFM requirements. At least one zone balancing damper shall be completely open.
8. Main Ducts - Adjust main ducts to within design CFM requirements and traverse for total CFM quantities.
9. Branch Ducts - Adjust branch ducts to within design CFM requirements. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.
10. Tolerances - Test and balance each diffuser, grille, and register to within 10 percent of design requirements. Test and balance all fans to within 5 percent of design requirements.
11. Identification - Identify the location and area of each grille, diffuser, register, and terminal box. This information shall be recorded on air outlet data sheets.
12. Description - Record the size, type, and manufacturer of each diffuser, grille, and register on air outlet data sheets.
13. Minimizing Drafts - Adjust all diffusers, grilles, and registers to minimize drafts in all areas.
14. Test and Balance Engineer shall witness and record all leakage testing of ductwork. Leakage test data shall be included in final Test and Balance Reports.
15. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable air volume systems at maximum air flow rate, full cooling, and at minimum airflow rate, full heating.
16. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
17. For heat pumps, assist start-up organization or manufacturer's representative with start-up. Record air flow rates, water flow rates and electrical characteristics

prior to refrigerant pressure measurement and settings.

3.4. WATER SYSTEM PROCEDURES

A. The various water circulating systems shall be filled, purged of air, and put into operation before hydronic balancing by the mechanical contractor.

B. The flow of water through all coils shall be adjusted by manipulating balancing valves until the rated pressure drop through the coil or metering device is obtained. Perform balancing by measurement of temperature differential in conjunction with air balancing.

C. The balancing agency shall perform the following testing and balancing functions in accordance with the AABC National Standards.

D. All Hydronic equipment, domestic re-circulating pumps, and HVAC pumps shall be Tested and Balanced as described below:

1. Water Treatment - Examine the water in the system and determine if the water has been treated and cleaned. If it has not, request the mechanical contractor to clean and treat the water prior to TAB work
2. Strainers - Request that the mechanical contractor clean all strainers.
3. Air Vents - Check all air vents at the high points of the water system and determine if they are installed and operating.
4. Valves - Set all balancing valves to the full-open position for balancing.
5. Pumps - Adjust all pumps and domestic hot water re-circ water pumps to meet design GPM requirements. Check pumps for proper operation. Pumps shall be free of vibration and cavitations. Measure and record operating current and voltage. Check and record thermal overloads installed on all pumps. Record in Test and Balance Report.
6. Tolerances - Proceed to balance all coils, pumps, solar equipment, and vertical u-tubes to within 5 percent of design requirements.
7. Marking - Mark all settings and record all data after completing the flow readings and coil adjustments.
8. Where available pump capacity (due to diversity) is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.
9. Test and verify proper operation of oil sensors at elevator pit sump pump and report results.

E. Heat Exchangers (Solar Tank Integral Heat Exchanger):

1. Verify that heat exchangers have been filled and started by others, and are in operation.
2. Test and adjust water flow through heat exchangers.
3. Test and record temperature and pressure profiles of water heat exchangers.
4. Verification: Verify the type, location, final pressure drop and GPM of each heat exchanger. This information shall be recorded on heat exchangers test forms.

F. Geothermal Heat Pump Test Forms - Record the following items on each geothermal heat

pump test form:

1. Manufacturer model number, serial numbers.
2. All design and manufacturer's rated data.
3. Service and location.
4. Actual pressure drop and design pressure drop of condenser/evaporator coils.
5. Entering and leaving water fluid of condenser/evaporator coils.
6. Temperature control settings.
7. Electrical characteristics.

G. Exterior Geothermal Heat Pump U-Tube Test Form:

1. Entering temperature, design and actual.
2. Leaving temperature, design and actual.
3. Primary water flow, design and actual.
4. Primary water pressure drop, design and actual.

H. Coils:

1. Tolerances - Test, adjust, and balance all hydronic coils within 5 percent of design requirements.
2. Verification - Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

3.5. DOMESTIC HOT WATER RE-CIRCULATING SYSTEMS PROCEDURES

A. The domestic hot water re-circulating system shall be tested and balanced as indicated on the contract documents including:

1. Balance of circuit setters to design quantities indicated on contract documents.
2. Balance of re-circulating pumps to meet design GPM requirements.

B. Domestic Water Heaters/Generators:

1. Verify that all domestic water heaters have been filled and started by others and are in operation.
2. Test and record outlet temperature of water heater at approximate design recovery.
3. Current and Voltage: As applicable, test and record voltage and amperage, compare data with nameplate limits to ensure water heater elements or burners do not exceed nameplate data.
4. Test discharge temperature and flow rate at all lavatory/hand sink mixing valves. Also measure time period for fixtures to obtain hot water.

3.6. LIFE SAFETY CONTROLS TESTING PROCEDURES

A. The TAB agency shall test and record life safety control operation on the HVAC equipment. It shall verify the installation of required smoke detectors in air handling

equipment (AHE), and shall verify operation of the smoke detector by activating the smoke detector and observing air handler shutdown. With the controls and alarm contractors, the TAB agency shall verify the operation of interconnected systems such as the AHU smoke detector's activation of the fire alarm system and the alarm system's activation of the life safety control sequences. Record results of tests within TAB report.

3.7. VERIFICATION OF TEMPERATURE CONTROL

A. The balancing agency shall be assisted by the temperature control contractor in verifying the operation and calibration of all temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.
3. Verify the accuracy of the final settings by taking temperature readings. The readings shall be in a typical conditioned space for each separately controlled zone.
4. Test and calibrate all air flow monitoring stations for proper air flow.
5. Test and calibrate all differential pressure sensors. Record set point in Record and Information Books.

3.8. TEST AND BALANCE REPORTS

A. The test and balance report shall be complete with logs, data, and records as required herein. All logs, data, and records shall be typed on white bond paper and bound. The report shall be certified accurate and complete by the balancing agency's certified test and balance engineer.

B. Six (6) copies of the test and balance report are required and shall be submitted to the Engineer. If, in the opinion of the Engineer, test results or portions thereof are incomplete or inconclusive, repeat necessary portions of the work to the satisfaction of the Engineer.

C. The report shall contain the following general data in a format selected by the balancing agency:

1. Project Number
2. Contract Number
3. Project Title
4. Project Location
5. Project Architect
6. Project Mechanical Engineer
7. Test & Balance Agency
8. Test & Balance Engineer
9. General Contractor

10. Mechanical Subcontractor
11. Dates tests were performed
12. Certification
13. Duct Leakage Tests
14. Phone Numbers of all Individuals Listed Above
15. Project Altitude

D. The test and balance report shall be recorded on report forms conforming to the recommended forms in the AABC National Standards.

3.9. TEST REPORT FORMS

A. Air Moving Equipment and Fan Test Forms - Submit fan curve showing design and operating points of operation. Also, record the following on each air-handling geothermal heat pump equipment test form:

1. Manufacturer, model number, serial number, arrangement.
2. All design and manufacturer-rated data.
3. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
4. Suction and discharge static pressure of each fan, as applicable. Include pressure drops across coils, filters, mixing boxes, and similar devices.
5. Outside-air, return-air, and exhaust air total CFM.
6. Actual operating current, voltage and brake horsepower of each fan motor. For packaged equipment, this includes supply fans, relief air fans, and condenser fans.
7. Final RPM of each fan.
8. Fan and motor sheave manufacturer, model, size, number of grooves, bore, and center distance.
9. Belt size, quantity and make.
10. Static-pressure controls final operating set points (if applicable).
11. Total and external static pressure.

B. Pump Test Forms - Submit pump curve showing design, operating, and no-flow points of operation. Also, record the following items on each pump test form:

1. Manufacturer, size, model, service and serial number.
2. All design and manufacturer's rated data.
3. Pump operating suction and discharge pressure and final total dynamic head.
4. No flow (pump discharge valve closed) suction and discharge pressure and corresponding total dynamic head. This procedure is to determine actual impeller size. Record impeller size.
5. Rated and actual operating current, voltage, and brake horsepower of each pump motor.
6. Total operating head pressure.
7. Shutoff, discharge and suction pressures.
8. Shutoff, total head pressure.

C. Heating and Cooling-Coil Test Forms - Record the following items on each test form:

1. Manufacturer, location, service.
2. All design and manufacturer's rated data.
3. Rated and actual water pressure drop through each coil and related GPM.
4. Rated and actual static pressure drop across each coil.
5. Rated and actual entering and leaving water temperatures across each coil.
6. Wet-bulb and dry-bulb temperatures entering and leaving each cooling coil; dry-bulb temperatures entering and leaving each heating coil.
7. Air flow (Design and Actual).
8. For DX-coil, provide design and actual saturated suction temperature.
9. For DX-Coil, provide suction and discharge pressures.

D. Air Monitoring Station Test Forms:

1. Identification /location.
2. Manufacturer.
3. Systems.
4. Size and Model Number.
5. Area.
6. Design Velocity.
7. Design Airflow.
8. Test Velocity.
9. Test Airflow.
10. Static Pressure Drop and Velocity Pressure.
11. Station Calibrated Setting.

E. Flow Measuring Station Test Forms:

1. Identification/location.
2. Manufacturer.
3. Size and Model Number.
4. Design and Actual Flow Rate.
5. Design and Actual Pressure Drop.

F. Electric Motors Test Forms: (Applies to all motors, including pumps, fans and HVAC equipment)

1. Manufacturer.
2. Model/Frame.
3. HP/BHP.
4. Phase, voltage, amperage; nameplate, actual, no load.
5. RPM.
6. Service factor.
7. Starter size, rating, heater elements.
8. Sheave Make/Size/Bore.
9. Thermal overload settings

G. V-Belt Drive Test Forms:

1. Identification/location.
2. Required driven RPM.
3. Driven sheave, diameter and RPM.
4. Belt, size and quantity.
5. Motor sheave diameter and RPM.
6. Center to center distance, maximum, minimum, and actual.

H. Duct Traverse Test Forms:

1. System zone/branch.
2. Duct size.
3. Area.
4. Design velocity.
5. Design air flow.
6. Test velocity.
7. Test airflow.
8. Duct static pressure.
9. Air temperature.
10. Air correction factor.

I. Duct Leakage Test Forms:

1. Description of ductwork under test.
2. Duct design operating pressure.
3. Duct design test static pressure.
4. Duct capacity, air flow.
5. Maximum allowable leakage duct capacity times leak factor.
6. Test apparatus.

    a). Blower.
    b). Orifice, tube size.
    c). Orifice size.
    d). Calibrated.

7. Test static pressure.
8. Test orifice differential pressure.
9. Leakage.

J. Air Distribution Test Sheet:

1. Air terminal number.
2. Room number/location.
3. Terminal type.
4. Terminal size.
5. Area factor.
6. Design velocity.
7. Design air flow.
8. Test (final) velocity.
9. Test (final) air flow.
10. Percent of design air flow.

K. Ductless Unit Test Forms:

1. Manufacturer
2. Type, air conditioning, heat pump
3. Identification number
4. Location
5. All design and manufacturer's rated data.
6. Rated and actual entering and leaving dry bulb temperatures.
7. Rated and actual entering and leaving wet bulb temperatures.
8. Air flow (design and actual)
9. Provide actual saturated suction temperature.
10. Actual operating current, voltage and brake horsepower of each fan motor.
11. Final fan RPM.
12. For Water Cooled Variable Refrigerant Volume System test water temperatures, current, voltage, fluid flow rate, and pressure drop of water cooled units.

L. Energy Recovery Ventilators Test Forms: Submit fan curve showing design and operating points of operation. Also, record the following on each air-handling equipment test form:

1. Manufacturer, model number, serial number, arrangement.
2. All design and manufacturer-rated data.
3. Total actual CFM by traverse if practical. If not practical, the sum of the outlets may be used, or a combination of each of these procedures. For specific systems, such as ones with diversity, see the AABC National Standards.
4. Suction and discharge static pressure of each fan, as applicable. Include pressure drops across coils, filters, energy wheels, and similar devices.
5. Outside-air, and exhaust air total CFM.
6. Actual operating current, voltage and brake horsepower of each fan motor.
7. Final RPM of each fan.
8. Fan and motor sheave manufacturer, model, size, number of grooves, bore, and center distance.
9. Belt size, quantity and make.
10. Total and external static pressure.
11. Rated and actual static pressure drop across each energy wheel.
12. Wet-bulb and dry-bulb temperatures entering and leaving each cooling coil, hot gas reheat coil and energy wheel. Dry-bulb temperatures entering and leaving each heating coil.
13. For DX-coil, provide design and actual saturated suction temperature.
14. Record carbon dioxide set points and actual readings for exhaust air stream at ERV and global CO_2 sensor.
15. Entering and leaving air temperatures at hot gas re-heat coil.
16. Exhaust airflow with Biofuel-Lab exhaust air damper open and closed.

M. Ground Heat Exchanger Test Forms:

1. Entering temperature, design and actual.
2. Leaving temperature, design and actual.
3. Primary water flow, design and actual.

4. Primary water pressure drop, design and actual.

N. Water Heater Test Forms:

1. Manufacturer, Model Number, and Serial Number.
2. Verify all safeties.
3. Record water temperature, actual, and design.
4. Verify operation in all modes of operation.

O. Thermal Solar System:

1. Manufacturer, Model Number and Serial Number.
2. Verify operation of differential controller.
3. Solar tank entering/leaving temperatures.
4. Solar collector entering/leaving temperatures.
5. All pump flow rates.
6. Heat exchanger flow rates, temperatures, etc...

END OF SECTION

DIVISION 23 SECTION 230600
HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT
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SECTION 230600 - HEATING, VENTILATING, AND AIR CONDITIONING EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 GENERAL

A. The Conditions of the Contract and other General Requirements apply to the work specified in this section. All work under this section shall also be subject to the requirements of Division 23 Section, *Common Work Results for HVAC* and Division 01 Section *General Requirements.*

1.3 DESCRIPTION

A. The work to be performed shall include all labor, materials and equipment necessary to furnish and install complete, all mechanical equipment as shown on drawings, hereinafter specified or reasonably implied, and leaving the same in satisfactory operation condition. It is the intent that systems be installed complete with all items necessary to accomplish this purpose.

1.4 SUBMITTALS

A. Shop Drawings: Indicate assembly, equipment dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.

B. Product Data:

1. Provide literature which indicates dimensions, weights, capacities, ratings, performance, gages and finishes of materials, and electrical characteristics and connection requirements.
2. Provide data of filter media, filter performance data, filter assembly, and filters frames.
3. Provide fan and pump curves with specified operating point clearly plotted.
4. Submit sound power level data for both fan outlet and casing radiation at rated capacity. Submit sound power levels by octave band or sound pressure levels by octave band for all equipment.

5. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of General Requirements.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store all equipment in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. Comply with manufacturer's installation instructions for rigging, unloading and transporting equipment.

E. Protect all motors, shafts, and bearings from weather and construction dust.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not operate any equipment for any purpose, temporary or permanent, until ductwork/piping is clean, filters/strainers are in place, bearings lubricated, and equipment has been test run under observation.

1.8 ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected

by alternates.

PART 2 PRODUCTS

2.1 FANS

A. General

1. Provide fans as indicated on the drawings. All fans shall have been tested and their performance rated in accordance with Air Movement and Control Association, Inc., Bulletin 210-85 Test Code and shall be licensed to bear the AMCA Seal. All fans shall carry the AMCA Certified Rating Seal for air and sound. Sound power levels shall be submitted for approval. Fan curves shall be submitted with all fan shop drawings.
2. Fan manufacturer shall submit under what duct configuration (unducted, partially ducted, or ducted) the manufacturer certified the performance of a particular fan or group of fans.
3. When indicated on Contract Drawings provide inverter duty rated motors for all variable speed fans.

B. Power Roof Ventilators

1. Direct Drive

a. Furnish and install direct driven power roof ventilators of the size, capacity, and electrical characteristics as shown on contract drawings.
b. Roof fans shall be centrifugal direct drive type.
c. The fan wheel shall be centrifugal backward inclined, constructed of aluminum and shall include a wheel cone carefully matched to the inlet cone for precise running tolerances. Wheels shall be statically and dynamically balanced. The fan housing and shroud shall be constructed of heavy gauge aluminum with a rigid internal support structure. The fan shroud shall have a rolled bead for added strength.
d. Motors shall be mounted out of the airstream on vibration isolators. Fresh air for motor cooling shall be drawn into the motor compartment from an area free of discharge containments. Motors shall be readily accessible for maintenance. Motors shall be “Vari Green” ECM motors.
e. A disconnect switch shall be factory installed and wired from the fan motor to a junction box within the motor compartment. A conduit chase shall be provided through the curb cap to the motor compartment for ease of electrical wiring.
f. All fans shall bear the AMCA Certified Rating Seal for sound and air performance.
g. Each fan shall bear a permanently affixed manufacturer's nameplate containing the model number and individual serial number for future identification.
h. Provide 12- inch high, fully insulated, aluminum roof curbs with each

ventilator. Fan and roof curbs shall be provided by the same manufacturer.

i. Provide 2-inch aluminum birdscreen with each fan.

j. Motor operated dampers shall be provided by ATC subcontractor and installed by mechanical contractor. Provide unit mounted solid state speed controller with each fan for balancing.

k. Fans shall be model G as manufactured by Greenheck Fan Corporation, ACME Engineering, Cook, Penn Ventilator, Twin City Fan and Blower or approved equal.

2.2 BASE MOUNTED PUMPS - END SUCTION

A. Furnish and install base mounted centrifugal end suction pumps to circulate hydronic water to the various items of equipment throughout the building, associated with the HVAC system. Pumps shall have sizes and capacities as indicated on the drawings.

B. Pumps shall be cast iron bronze fitted and shall be suitable for up to 175 psi working pressure and up to 250 degrees F water temperature. Pumps shall have center-line discharge for positive venting and flanged bodies. Pumps shall incorporate a grease lubrication system and be so designed that the bearing assembly can be removed in one piece. A water slinger shall be provided between the mechanical seal and bearing areas. Pump shafts shall be stainless steel with a cupro-nickel sleeve, and be coupled to the motor shaft by a noiseless, non-metallic coupler with guard. Impellers shall be one piece cast bronze, dynamically balanced. Motors shall be 1750 rpm.

C. Pumps shall be designed so that they shall not overload at low heads and shall not develop excessive pressure under throttled flow conditions or overload motor anywhere on the operating curve. Operating performance curves shall be submitted for approval. Provide gauge tappings on each pump flange. Furnish dust caps at all oil fill tubes. Pump motors shall be non-overloading throughout the range of the curves.

D. Units shall be provided with motors of not less than the horsepower indicated, suitable for the service and available electrical characteristics. Units shall be controlled as hereinafter specified. After installation and prior to operation, each pump shall be aligned. Motors shall be as specified hereinbefore.

E. Casing: Cast iron, with suction and discharge gage ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

F. Impeller: Bronze, fully enclosed, keyed to shaft.

G. Baseplate: Cast iron or fabricated steel with integral drain rim.

H. Pumps shall be primed and painted in baked enamel, rust resistant paint.

I. Electrical characteristics shall be as scheduled on the contract drawings. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA-70.

J. Pumps shall be FE series as manufactured by Taco, 2000 Series by Allis Chalmers, Aurora, Bell & Gossett, PACO, Armstrong, Patterson, or as approved equal.

2.3 IN-LINE CIRCULATING PUMPS

A. Furnish and install in-line circulating pumps as shown on the contract drawings. Pump and motor shall be equipped with sleeve bearings for quiet operation. Pumps shall be suitable for up to 175 psi working pressure and up to 300 degrees F water temperature as per ASA B16.1. Pump rating curves shall be the result of testing and rating in accordance with the procedures of the Hydraulic Institute.

B. Pump motors shall be non-overloading throughout the range of the curves. Pumps shall have center-line discharge for positive venting, flanged bodies, and same size suction and discharge. Pumps shall incorporate a disc type lubrication system and be so designed that the bearing assembly can be removed in one piece. One bearing assembly shall be suitable for all sizes of the inline pumps furnished. Sump oil temperature may not exceed 180 degrees F when circulating 250 degrees F water with a 90 degree F ambient. Vent and drain openings at least 3 square inches in area and a water slinger shall be provided between the mechanical seal and bearing area. This water slinger shall be integral with shaft sleeve. All in-line circulating pumps shall be provided with all bronze construction when used in open system and shall be bronze fitted for closed system.

C. Provide gauge tappings on each pump flange.

D. Pump body shall be cast iron and pump shafts shall be alloy steel with cupro-nickel sleeve covering all wetted parts, and be coupled to the motor shaft by a noiseless non-metallic coupler. Impellers shall be one piece cast bronze, dynamically balanced. Pumps shall have a two piece mechanical seal assembly easily replaceable without the use of special tools. Motors shall be resilient mounted, 1750 RPM, and require no external overload protection when used with single phase current.

E. Electrical characteristics shall be as scheduled on the contract drawings. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA-70.

F. In line pumps shall be Red Baron Series 110 in-line circulators or 1600 Series, as manufactured by Taco, Bell & Gossett, Thrush, Armstrong, Patterson, Wilo, Grundfos, or as approved equal.

2.4 VARIABLE SPEED DRIVES

A. Provide variable speed drive controllers for pumps as indicated on contract drawings.

B. ERV variable speed drives shall be factory furnished by ERV unit manufacturer.

C. The adjustable frequency controller (AFC) shall convert three phase 60 Hertz utility power to adjustable voltage and frequency, three phase, AC power for stepless motor control from 5

percent to 110 percent of base speed.

D. The AFC shall be a voltage source type with a PWM output utilizing power transistor semi-conductors.

E. The AFC together with all options and modifications shall mount within a standard NEMA 1 enclosure suitable for continuous operation at ambient temperature of 0 to 40 degrees C. with relative humidity to 95 percent non-condensing. All high voltage components within enclosure shall be isolated with steel covers. The complete unit shall be UL approved and UL labeled.

F. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. AFC 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. Motor overload.
2. Shortcircuit.
3. Motor overtemperature fault.
4. Reverse phase.
5. 110 percent of controller maximum sine wave current rating is exceeded.
6. Output phase to phase and phase to ground short circuit condition.
7. High input line voltage.
8. Low input line voltage.
9. Loss of input phase.
10. External fault. This protective circuit shall permit, by means of the terminal strip, wiring of remote NC safety contacts to shut down the drive.

G. The following adjustments shall be available in the controller and retained in non-volatile memory:

1. Maximum frequency (15 to 400 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 percent torque.
7. Current limit (50 percent to 110 percent sine wave current rating) factory set at 100 percent current.

H. The AFC shall have the following basic features:

1. Door-mounted operators controls consisting of a membrane command center which allows manual stop/start and speed control, local/remote indication and manual/or automatic speed control selection. In addition, the command center shall serve as a means to configure controller parameters such as min speed, max speed, acceleration and deceleration times, Volts/Hz ratio, torque boost etc. Potentiometers shall not be allowed for these settings.
2. Main input disconnect to provide a positive disconnect between the controller and all phases of the incoming A-C line. This disconnect shall be mounted inside the

controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.

3. Electronic motor overload relay.
4. Automatic restart after power outage, drive fault or external fault, with drive in automatic mode. The circuit shall allow the user to select up to (10) restart attempts as well as the dwell time between attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center.
5. Door-mounted LED display for digital indication of:

    a. Frequency output
    b. Voltage output
    c. Current output
    d. First fault indication
    e. Fan or Pump Speed (RPM)

6. Relay contacts for remote indication of drive fault and motor finning.
7. Three critical frequency avoidance bands, field programmable via the membrane command center. Each critical frequency avoidance band shall have a bandwidth adjustable via keypad entry of up to 10 Hz.
8. Three programmable preset speeds which shall force the AFC to a preset speed upon a user contract closure.
9. Isolated process follower to enable VFC to follow a 4-20 mA signal.
10. The AFC shall have the capability to ride through power dips up to 500 msec without a controller trip depending on load and operating condition.
11. Line reactor to minimize line surges, line notching, and voltage distortions.

I. Manual bypass-to-line with magnetic contactors to transfer motor from the variable frequency controller to full 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 bypass power line and the motor, providing across-the-line starting.

J. Motor protection per National Electrical Code shall be provided in both the "controller" mode and the "bypass" mode by a motor overload relay. The 115 volt A-C relay control logic, allowing common start/stop commands in the "controller" mode and the "bypass" mode shall also be included within the enclosure.

K. The bypass shall include a door interlocked, main power input circuit breaker providing positive shutdown of all power to both the bypass circuitry and the VFC. The bypass circuit shall also include a second input disconnect to the VFC. This disconnect shall provide the ability to safely trouble shoot and test the controller, both energized and de-energized, while operating the bypass mode.

L. The VFC and all components shall be supplied within a single NEMA 1 enclosure, and shall be U.L. Listed as a single unit. Furnish all components necessary to provide a minimum lead length between motor and drive of 400 ft. The VFC shall not generate damaging transistor pulses greater than the limits set by NEMA MG-1 at 400 Ft lead length.

M. The VFC manufacturer shall maintain and staff nationwide service centers. These service engineers shall be employed by the manufacturer and provide start-up service including physical inspection of drive and connecting wiring and final adjustments to meet specified performance requirements.

N. The VFC shall carry a full parts and labor warranty for two years from date of Owner acceptance of the building.

O. The variable speed drive shall be ABB, or approved equal of Accutrol, Cutler Hammer, Graham, York, Baldor, AC Tech, Trane, Emerson, or as approved equal.

P. The variable speed drive manufacturer shall coordinate with the ATC contractor and provide all necessary devices whether optional or not to perform complete and automatic operation as described in the sequence of operation. All safeties shall be enabled when variable speed drives are in manual or bypass.

Q. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

R. Variable speed drives shall be carefully selected for the duty required. Variable speed drives shall be specifically designed for the specified equipment to be controlled. Pump drives shall be selected for pumps.

2.5 COALESCING AIR SEPARATOR

A. Furnish and install as shown on the drawings a Spirotherm, Bell and Gossett, Taco 4900 Series, Caleffi, Armstrong or approved equal air elimination separator. All fittings shall be fabricated steel, rated for 150 psig design pressure and 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. All units shall include an integral copper bundle of Spirotubes or approved equal, to act as the turbulence suppressive coalescing medium which must completely fill the fitting's internal area. Units are to remove free and entrained air during system start up and continue to eliminate dissolved air through continual circulation and the coalescing action of the Spirotubes. Each fitting is to have a separate air and venting chamber to prevent system contaminants from harming the float and venting valve operation. At the top of the venting chamber shall be an integral float actuated brass air vent. There shall be no restriction in the connection from the venting chamber to the vent. The fittings are to include a valve side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill. Units shall include a bottom connection for use as a blow down connection for periodic cleaning. Air separator shall be primed and finished in rust resistant paint. Units shall be Spirovent Senior models of the size required to meet pressure drop and velocity criteria.

B. A blowdown connection shall be provided to facilitate routine cleaning of the strainer and the separator.

C. A manufacturer's data report for pressure vessels, for U-1 as required by the provisions of ASME Boiler and Pressure Vessel code, shall be furnished for each air separator upon request. Manufacturer to furnish data sheet specifying air collection efficiency and pressure drop at rated flow.

D. Conventional tangential or centrifugal non-coalesing air separators shall **not** be acceptable.

2.6 EXPANSION TANKS

A. Furnish and install as shown on the drawings, pre-pressurized captive air bladder type expansion tank pre-charged with air. Tank shall be suitable for a maximum working pressure of 125 psi and constructed and certified to ASME Section VII. It shall have a replaceable elastomeric bladder suitable for a maximum operating temperature of 240 degrees F (115 degrees C). Expansion tanks shall be primed and finished in rust resistant paint. It shall have an integral steel base ring for vertical mounting and saddle for horizontal mounting. Expansion tank shall be as manufactured by Taco, Bell & Gossett, Wessels, Amtrol, Armstrong or as approved equal.

2.7 AIR CONDITIONING CONDENSATE PUMPS

A. Provide and install air conditioning condensate pumps of the size, capacity, and electrical characteristics as shown on the contract drawings. Units shall be Little Giant, Beckton, Diversitech, or approved equal.

B. Units shall be U.L. listed and CSA certified. Each pump shall include 6 ft power cord with 3 prong molded 115 volt plug and thermal overload protection. Include low voltage safety switch with polypropylene float that shall be wired to cut-off the indoor unit in the case of malfunction. Safety switch should be connected to a Class II low voltage safety device.

C. Housing shall be constructed of high impact resistant polystyrene, ABS impeller and volute, and stainless steel shaft. Mount units directly below adjacent existing indoor units and pipe discharge with check-valve as shown on the drawings.

2.8 EXTERIOR EQUIPMENT/DUCT SUPPORT

A. Exterior Equipment Supports shall be Pate Model ES suitable for roof construction. Equipment supports shall be constructed of 18 gauge galvanized steel, unitized construction with integral base plate, continuous welded corner seams, pressure treated wood nailer counterflasing and lag screws. Units shall be internally reinforced. Minimum height shall be 12-inches above the finished roof or as shown on the detail(s) on the drawing(s).

2.9 AIR MONITORING STATIONS (ERV)

A. General: Provide complete air monitoring station for ERV units units, as indicated on drawings. The air monitoring station shall include airflow measuring stations, static pressure probes and electronic velocity pressure transmitter. All components shall be of the same manufacturer. The manufacturer shall be Air Monitor or as approved equal. An air monitor station shall be provided for each supply duct main as indicated on contract drawings. All air flow monitoring stations shall be fully externally insulated to prevent condensation.

B. Air Monitor Airflow Measuring Stations

1. Provide where indicated, airflow measuring stations capable of continuously monitoring the fan or duct capacities (air volumes) they serve.
2. Each airflow measuring station shall contain multiple total and static pressure sensors positioned at the center of equal area of the station cross-section and interconnected by their respective averaging manifolds. For stations of 4 square feet or less, one total and one static pressure sensor shall be present for every 16 square inches of station area respectively. For stations of larger area, one total and one static pressure sensor shall be present for every 36 square inches of station area respectively.
3. The airflow measuring station shall be fabricated of a minimum of 14 ga. galvanized steel, welded casing in 8-inch depth with 90 degree connecting flanges in a configuration and size equal to that of the duct it is to be mounted into. Each station shall be complete with an open parallel cell air straightener or air equalizer honeycomb mechanically fastened to the casing, total and static pressure sensors located on an equal area basis and connected to symmetrical averaging manifolds, internal piping, and external pressure transmitter ports. An identification label shall be placed on each station casing listing model number, size, area, and specified airflow capacity.
4. Cell construction shall be 3/8-inch .003-inch, type 3003 aluminum, expanded.
5. The maximum allowable pressure loss through the station shall not exceed .015-inch wc at 1000 fpm, or .085-inch wc at 2000 fpm. Each station shall be capable of measuring the airflow rate within an accuracy of 2 percent as determined by U.S.G.S.A. certification tests. The stations shall have a self-generated sound rating of less than NC 40, and the sound level within the duct shall not be amplified, nor shall additional sound be generated.
6. Stations shall be Fan-E type as manufactured by Air Monitor Corporation, Paragon or as approved equal.

C. Air Monitor Duct Static Pressure Traverse Probes

1. Provide where indicated duct static traverse probe capable of continuously monitoring the duct or system static pressure it serves.
2. Each duct static traverse probe shall contain multiple static pressure sensors located along the exterior surface of the cylindrical probe. Said sensors shall not protrude beyond the surface of the probe.
3. The duct static traverse probe shall be of extruded aluminum construction and (except for ¾-inch diameter probes with lengths of 24-inches or less) be complete with threaded end support rod, sealing washer and nut and mounting plate with gasket and static pressure signal fitting.

4. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 0.5 percent.
5. The duct static pressure traverse probe shall be the STAT-probe/1 as manufactured by the Air Monitor Corporation, Paragon or as approved equal.

D. Air Monitor Electronic Velocity Pressure Transmitters

1. The electronic control-instrument components shall be of industrial process control quality with operating features described herein and capable of producing the outlined performances. Commercial grade control-instruments, devices, are not acceptable.
2. The electronic differential pressure transmitter shall include an automatic zeroing circuit capable of automatically readjusting the transmitter zero at predetermined (adjustable) time intervals while retaining (locking in) the output signal. The electronic differential pressure transmitter shall be capable of receiving signals of duct total and static pressures, and of amplifying and scaling the sensed differential pressure into a 4-20 mADC or 0-5 (0-10) VDC output signal linear to differential pressure, within the following minimum performance criteria:

Zeroing	Automatic, within 0.1 percent of operating span, on 4 to 256 minute intervals (selectable)
Spans	Factory custom spanned, coordinated with system, ranges from 0 to .01-inch to 0 to 10.0-inches. Field adjustment $\pm$20 percent of span.
Accuracy	$\pm$ 0.25 percent of span
DeadBand and Hysteresis (Combined):	Less than 0.2 percent of span
Linearity:	$\pm$ 0.2 percent of span
Repeatability:	0.15 percent of span
Response:	0.5 second for 98 percent full span input
Power Supply:	24 VAC, 20 to 40 VDC, selectable; 4 wire

3. Coordinate requirements with the buildings direct digital control system to perform the required sequence of operation.
4. The pressure transmitter shall be the VELTRON series 5000AZ as manufactured by the Air Monitor Corporation, Paragon, Greenheck, Johnson Controls, or as approved equal.

2.10 WATER TREATMENT SERVICES:

A. Complete chemical water treatment service shall be provided by an organization regularly engaged in water treatment, ARC, Inc., RCCO Corp., Aquatel Ind., Inc., Mogul Corp., Oilin, Inc., HVAC Services, Inc., Feedwater Treatment Systems, Inc., Eco-Lab, or approved equal. The service shall provide all equipment, chemicals and labor necessary to prevent corrosion, inhibit scale build-up and minimize organic growth for a period of 2 yearsstarting from building acceptance. Water Treatment shall be conducted for each phase prior to substantial completion of each phase. Service visits for the purpose of adding chemicals to feeding equipment, regulating bleed-off, inspecting and adjusting water treatment equipment, and obtaining samples of laboratory analysis shall be performed at monthly intervals for closed systems and every two weeks for open systems during the entire guarantee period. Chemicals shall not be injurious to water side equipment and construction materials. Records of all injurious to water side equipment and construction materials. Records of all service visits, chemical additions, laboratory tests, etc., shall be maintained and shall be provided to owner after each visit during guarantee period. Instruct mechanical contractor in field on piping and wiring of chemical feeding equipment.

B. Systems to be protected shall include dual temperature, and geothermal systems. Services shall include flushing and cleaning of piping systems specified under Division 23 Section, "*HVAC Piping, Fittings, and Valves*" section, furnishing and installing all chemical treatment equipment and accessories to perform the water treatment specified below. Maintain complete records of the treatment program for each system.

C. Contractor shall perform an analysis of the building water supply as a basis of the chemical treatment. Contractor shall provide the Owner with written instructions for chemical feeding bleed-off, blowdown control and testing procedures, provide all required chemicals during the guarantee period, and provide all required test kits.

D. Contractor shall maintain the following conditions in each system:

SYSTEMS	Geothermal Heat Pumps System
ph	7.0 to 10.0
Organic Inhibitor	---
Cycles*	---
Organic	---
Buffered Nitrate	550 ppm
Chromate (Low)	
Molybdate	30 to 50 ppm
Sulfite	---
*Actual cycles of concentration to be determined from analysis of make-up water.	

E. Chemical Feeding Equipment: Provide chemical feeding equipment, as specified below, to

introduce chemicals into each system only when the system is operating.

1. Closed Recirculating Systems

   Five (5) gallon steel by-pass feeder installed across circulating pump suction and discharge lines, with tank and piping insulated using the same thickness and type of insulation as provided for the piping system. Provide filter. Unit shall contain quick opening cap and shall be suitable for working pressure of 175 psig. Tank shall be primed and finished in baked enamel paint.

F. Closed Recirculating Systems shall be filled and 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. The automatic make-up valve shall be checked to be sure it is operating. Bleeding shall continue until water runs clear and all detergent is removed. A sample of water shall be tested and if PH exceeds the PH of the make-up water, flushing shall be resumed.

2.11 ENERGY RECOVERY VENTILATOR (BASE BID)

A. General

1. The unit(s) shall be installed in strict accordance with the specifications. Unit(s) shall be complete with all components and accessories as specified. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan and blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995/CAN/CSA C22.2 No. 236.
2. Units shall be manufactured by Aaon, Venmar, or approved equal.
3. Unit shall consist of packaged ERV/air handling unit with hot gas re-heat coil, heat pump coil, controls, filter housing, enthalpy wheel, variable frequency drives, inverter duty motors, demand control ventilation, and packaged heat pump unit.
4. Furnish and install motor bearing protective rings at all variable frequency drive motors. Refer to Division 01 Section, “Common work Results for HVAC”.

B. Quality Assurance

1. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
2. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
3. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
4. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.
5. Unit and components shall be designed, manufactured, and independently analyzed,

rated and certified to meet with the seismic compliance standards of the International Building Code, 2010 edition, Section 1621. If requested, unit shall be provided with Certificate of Compliance indicating that the unit and components meet seismic design requirements.

C. Warranty

1. Manufacturer shall provide a total warranty for a period of 24 months from the date of substantial completion. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

D. 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 D-1929 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. Exterior shall be primed and painted in color as selected by the Engineer.
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. Refrigerant 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, exhaust fans, energy recovery wheels, compressors, condensers, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.
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 shall include double sloped 304 stainless steel drain pans.
9. Unit shall include lifting lugs on the top of the unit.
10. Unit shall be provided with bottom discharge and return openings. All openings through the base pan shall have upturned flanges at least ½ inch in height around the

opening.

E. Weather Hoods:

1. Outside air intake hood shall be designed for maximum 450 FPM air velocity. The exhaust outlet hood shall contain a bird screen and shall have a non-restricting design.

F. Electrical

1. Unit shall be provided with standard power block for connecting power to the unit.
2. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
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 that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.
4. Unit shall be provided with manual reset low temperature limit controls which shut off the unit when the discharge temperature reaches a field adjustable setpoint.

G. Supply Fans

1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.
2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
3. Motors shall be inverter duty rated, 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.

H. Exhaust Fans

1. Exhaust dampers shall be sized for 100% exhaust air flow rate.
2. Fans and motors shall be dynamically balanced.
3. Motors shall be inverter duty rated, 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 handles.
5. Variable frequency drives shall be factory wired and mounted in the unit.

I. Evaporator Coil

1. Evaporator Coil

   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 helium leak tested.
   d. Coils shall be furnished with a factory installed thermostatic expansion valves.

J. Refrigeration System

1. Unit shall be factory charged with R-410A refrigerant.
2. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5 year warranty. Heating and cooling shall be provided by a geothermal water source heat pump system.
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 insulated 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 thermostatic 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 factory installed liquid line filter driers.
7. Unit shall include modulating capacity control through digital variable capacity scroll compressors.
8. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit(s) which shall be capable of modulation from 10-100% of its capacity.
9. Lead refrigeration circuit(s) shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
10. Each refrigeration circuit shall each be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump heating mode of operation.
11. Each refrigeration circuit shall include adjustable compressor lockouts.

K. Heat Pump

1. Water-Cooled Heat Pump Unit

    a. Heat Pump heat exchanger shall be cupronickel copper coaxial type.
    b. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes.
    c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
    d. Coils shall be helium leak tested.

L. Filters

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 7, upstream of the cooling coil. Furnish a complete set of spare filters.

M. Demand Control Ventilation Components

1. Energy recovery ventilator fans shall be controlled by a variable frequency drive. Outdoor air and exhaust air fans shall be controlled simultaneously to maintain desired building pressure. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and exhaust air volumes are always maintained. The variable frequency drive shall be factory mounted in the unit cabinet and wired.
2. Energy recovery ventilator shall be equipped with demand control ventilation capabilities that enable the varying of outdoor air and exhaust air volumes based on building occupancy. A sensor shall be located in the exhaust air stream and in the locations shown on the drawings to monitor average CO2 levels of the occupied spaces. A variable frequency drive shall receive a 0-10 volt signal from the CO2 sensor and control the outdoor air volume to maintain a maximum of 1,000 ppm (adjustable based on reset schedule) of CO2 in the occupied space. Outdoor air and exhaust air fans shall be controlled simultaneously to maintain desired building pressure. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and exhaust air volumes are always maintained. The exhaust sensor and variable frequency drive shall be factory mounted and wired. The space CO2 sensors shall be field installed and field wired.
3. Furnish each energy recovery ventilator with the following:

    a. Supply air fan variable frequency drive.
    b. Exhaust air fan variable frequency drive.
    c. Carbon Dioxide (CO2) Sensor.
    d. Furnish one unit with additional outside air carbon dioxide (CO2) sensor to display ambient CO2 levels. (Interlock with ATC system.)

N. Energy Recovery

1. Unit shall contain a factory mounted and tested energy recovery wheel(s). The energy recovery wheel(s) shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.
2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
3. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
4. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

5. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
6. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with *ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers* and *AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.*
7. Energy recovery wheel cassette shall carry a 5 year warranty.
8. Furnish spare energy recovery wheel belt.
9. Hinged service access door shall allow access to the wheel(s).
10. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

O. Controls

1. Factory Installed and Factory Provided Controller

   a. Provide modular system manager for control of energy recovery ventilator at unit.
   b. 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.
   c. 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.
   d. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
   e. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
   f. Modulating hot gas re-heat shall be supplied with a field installed supply air temperature sensor to control the amount of re-heating. Supply air temperature setpoint shall be field adjustable.
   g. With the modulating hot gas reheat option a space humidity sensor and supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity setpoints, for the dehumidification mode of operation, shall be adjustable.
   h. Outside air temperature sensor shall be factory mounted and wired. Supply

air temperature sensor shall be furnished with the unit for field installation.

i. Furnish controls with the necessary interfaces to communicate via BACNET/IP or LonWorks to a building automation system.

j. All inputs and outputs on the manufacturer's controller shall be viewable via the interface.

k. All setpoints and schedules shall be editable via the interface by the Building Automation System.

l. In addition to standard inputs/outputs provide additional inputs/outputs as required to accomplish sequence of operation and items listed on point list.

m. The manufacturer shall be responsible for assisting and participating in the integration of the equipment into the Building Automation System and shall provide programming, testing, verification and on site personnel as required.

P. Unit Sequence of Operation

1. General

a. ERV supply fan and ERV exhaust fan shall be interlocked to operate simultaneously.

b. When the ERV is de-energized, the outside air damper, (D-1) and exhaust air damper (D-2) shall close. The heat pump unit shall de-energize whenever the ERV fans are de-energized.

c. All dampers shall be provided with end switches to prevent operation of ERV supply fan and ERV exhaust fan until dampers are proved open.

d. The energy recovery unit shall operate with packaged controls to stage compressors and modulate compressor speed to provide heating/cooling. ATC subcontractor shall coordinate with energy recovery unit manufacturer's controller to provide all requirements, interlocks, relays, etc.

e. Furnish supply air and exhaust air variable frequency drives and carbon dioxide sensors to allow air flow modulation based on carbon dioxide levels.

f. All set point temperatures shall be resettable and adjustable through software. All temperature sensors shall be monitored.

g. A global outside air carbon dioxide sensor shall allow re-set of $C0_2$ sensor set points based on outside air CO_2 levels.

h. Field install space humidty sensor for dehumidification and hot gas reheat control.

i. Provide differential static pressure sensors to determine filter loading of the ERV.

2. Occupied Cycle:

a. The energy recovery ventilator fans and energy recovery wheel shall operate continuously to provide tempered, 100 percent outside air to the spaces.

b. The unit shall be arranged for a winter time morning warm-up cycle and a summer time morning pull down cycle (from 8:00 a.m. to 9:00 a.m.).

c. Morning warm-up cycle: During morning warm-up cycle, the outside air

damper, (D-1), shall open and exhaust air damper (D-2) shall open. The energy recovery wheel shall rotate continuously. The unit fan shall operate in morning warm-up mode until the discharge air temperature (T-1) rises to 70 degrees F (adjustable). At that point the heat pump shall operate under its packaged controls to provide heat in stages to maintain discharge air temperature at 72 degrees Fahrenheit.

d. Morning pull down cooling cycle: During morning pull down cooling cycle, the outside air damper (D-1) shall open and exhaust air damper (D-2) shall open. The energy recovery wheel shall rotate continuously. The packaged discharge air temperature controller (T-1) shall operate unit under packaged controls and energize the condensing unit to provide cooling in stages. The ERV shall remain in the morning pull down cycle until the discharge air sensed at T-1 drops to 78 degrees F (adjustable). The ERV shall then run continuously. Simultaneously, the condensing unit controller shall be placed under the control of the packaged discharge air temperature controller, (T-1). Upon completion of morning cool down period, the discharge air temperature controller, T-1, shall operate the unit cooling coil and hot gas re-heat coil to maintain space neutral (75 deg F, adjustable) discharge air conditions. A space humidity sensor shall override the discharge air temperature to provide dehumidification while providing hot gas re-heat. Summer space humidity shall be maintained at 50% R.H.

e. Discharge air temperature (T-1) shall be resettable and adjustable through software.

f. Demand Controlled Ventilation: The main exhaust air stream prior to energy recovery wheel shall contain a CO2 sensor and select spaces will contain a CO2 sensor. CO2 sensors shall modulate the supply and exhaust air streams to maintain the CO2 level at 1,000ppm (adjustable based on reset schedule). The minimum fan airflow rates shall be as scheduled. Set up and test minimum airflow rates with Test & Balance Engineer so that fans do not operate below minimum airflow rates regardless of measured CO2 levels. The CO_2 sensors shall modulate air flow rates in a linear fashion from minimum to maximum based on CO_2 measurements and re-set schedule. Coordinate with ATC Subcontractor. The CO2 sensor with the highest reading shall take priority control of fans using a discriminator control strategy.

3. Unoccupied Cycle:

a. During the unoccupied cycle the supply fan and exhaust air fans shall be de-energized. Outside air damper (D-1), exhaust damper (D-2), shall close and the refrigerant system shall de-energize when the supply fan is turned off.

Q. Dampers

1. Dampers shall be installed where shown on the drawings. Dampers shall be low leak type with rubber edges, opposed or parallel blades, and constructed from extruded aluminum. Galvanized dampers will not be acceptable. The exhaust air outlet shall have a standard aluminum gravity type damper, unless otherwise noted below.

2. Dampers shall be installed in the following compartments with linkage rod for actuators (actuators to be furnished and installed under Division 23 Section, *Instrumentation and Controls of HVAC and Plumbing Systems*).

   a. Outdoor air intake.
   b. Exhaust outlet.

R. Roof Curb

1. A non-insulated, pre-fabricated roof curb shall be provided and shipped knocked down. The roof curb shall be made of 16-gauge galvanized steel with 4" flanges, minimum 17" high with a factory installed 2" x 3" wood nailer strip.

S. Extra Materials

1. Furnish extra materials described below that match the products installed, are packaged with protective covering for storage, and are identified with labels describing contents:

   a. Filters: Furnish one set of each type of filters.
   b. Fan Belts: Furnish one set of belts for each belt drive fan in energy recovery ventilator.
   c. Wheel Belts: Furnish one set of belts for each belt driven energy wheel.

T. Warranty: Entire unit including controls shall be warranted for a minimum of two (2) years including parts and labor. Compressor warranty shall be five (5) years including parts and labor.

U. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms. Allows WFC to be used with an external system within a multidrop LAN configuration; setting retained within VFC's nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.
2. Embedded BAS Protocols for Network Communication: ASHRAE 135 BACnet; protocols accessible via the communications ports.

2.12 HOSE KITS

A. Provide hose kits at all water source heat pumps of the minimum size as scheduled on the Contract Drawings or as requird to meet pressure drop limitation whichever is greater. Hose kits shall be provided for all water connections to water-to-air and water-to-water heat pumps. Hoses shall be Metroflex Elasto-Flex, Griswald, Hastings, or approved equal.

B. Furnish hose kits with all necessary brass fittings for connections of heat pumps to runouts as detailed on drawings. Tubing shall be nontoxic polythene tube with galvanized or stainless steel, steel braid and rust resistant connectors - male and female swivel.

C. Hose shall be constructed for 185 psig working pressure and 740 psi burst pressure, -20

degrees F to 230 degrees F temperature range.

D. Hose lengths shall be 12 inches, with MPT adapter and pipe reducer fitting.

E. At Contractor's option hose kits may be combined with strainers, valves, P/T ports, unions, auto flow valves, and 2 position control valves into a factory assembly. Hose kit total pressure drop for entire assembly including all devices and both hoses shall not exceed 10 feet at scheduled flow rate.

F. Coordinate with Division 23 Section, *Instrumentation and Controls of HVAC and Plumbing Systems* regarding 2 position valves and actuators if hose kits are to be furnished under this section.

2.13 DENATURED ETHYL ALCOHOL (ENVIRONOL)

A. General

1. The geothermal heat transfer fluid shall be based on a renewable denatured ethyl alcohol (grain) approved and listed for use as a heat transfer/antifreeze with the United States Bureau for Alcohol, Tobacco and Firearms with the following qualities. The heat transfer fluid shall be Environol, Exoendosol, or approved equal.

B. Appearance

1. The fluid shall have a pine aroma and be light blue in color.

C. Performance

1. The performance shall be as follows:
   a. Viscosity shall be no more than 5.00 centipoise at 30 degrees F with blend for 15 degrees F freeze protection.
   b. Specific heat shall be 1.05 at 70 degrees F with blend for 20 Degree F freeze protection.
   c. Specific Gravity shall be 0.982 at 50 degrees F with blend for 20 degrees F freeze protection.
   d. Pressure drop and Reynold's Number for a 3 gpm flow in ¾" IPS SDR11PE pipe of a 30 degrees F mixure for a 15 degrees F freeze protection blend shall be no more than 2.83 ft of hd per 100 ft of pipe and no less than Re-2028 (Reynolds number).
   e. Freeze Protection: 25% by volume to provide 15 degreese Fahrenheit freeze protection.

D. Application

1. The fluid shall mix easily and readily with water and shall not damage or corrode common tools.

E. Corrosion

1. The fluid shall be compatible with iron, copper, red and yellow brass, polyethylene, PVC, viton, buna "N", neoprene and nylon, and shall contain an oxygen scavenger blend to reduce any corrosion capability.

F. Health

1. The fluid shall have an NFPA rating of 0 (least risk).

G. Furnish antifreeze pre-mixed with deionized water and install in the geothermal system.

2.14 ENERGY RECOVERY VENTILATOR (ALTERNATE)

A. General

1. The unit(s) shall be installed in strict accordance with the specifications. Unit(s) shall be complete with all components and accessories as specified. All units shall be factory assembled, internally wired, and 100% run tested to check operation, fan and blower rotation and control sequence before leaving the factory. Wiring internal to the unit shall be numbered for simplified identification. Units shall be ETL listed and labeled, classified in accordance with ANSI-UL 1995/CAN/CSA C22.2 No. 236.

2. Units shall be manufactured by Aaon, Venmar, Greenheck, or approved equal.

3. Unit shall consist of packaged indoor ERV/air handling unit with hot gas re-heat coil, heat pump coil, controls, filter housing, enthalpy wheel, variable frequency drives, inverter duty motors, and remote outdoor heat pump unit.

4. Furnish and install motor bearing protective rings at all variable frequency drive motors. Refer to Division 23 Section, "Common work Results for HVAC".

B. Quality Assurance

1. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

2. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.

3. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.

4. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.

5. Unit and components shall be designed, manufactured, and independently analyzed, rated and certified to meet with the seismic compliance standards of the

International Building Code, 2010 edition, Section 1621. If requested, unit shall be provided with Certificate of Compliance indicating that the unit and components meet seismic design requirements.

C. Warranty

1. Manufacturer shall provide a total warranty for a period of 24 months from the date of substantial completion. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, provided manufacturer's written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts and air filters.

D. 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 D-1929 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. Exterior shall be primed and painted in color as selected by the Engineer.

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. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

5. Access to filters, dampers, cooling coils, reheat coil, exhaust fans, energy recovery wheels, compressors, condensers, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full length stainless steel piano hinges shall be included on the doors.

6. 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.

7. Units shall include double sloped 304 stainless steel drain pans.

8. Unit shall include lifting lugs on the top of the unit.

E. Electrical

1. Unit shall be provided with standard power block for connecting power to the unit.

2. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.

3. Air-source heat pump shall include an optimized start defrost cycle to prevent frost accumulation on the outdoor coil during heat pump heating operation and to minimized defrost cycle energy usage. If the temperature of the outdoor heat exchanger and/or the suction line is less than a predetermined value, a deferred defrost cycle is initiated wherein the defrost cycle starts after a variable, continuously optimizing, time interval has elapsed. The defrost cycle is terminated when the relative temperatures of the outdoor heat exchanger and/or the suction line indicate that sufficient frost is melted from the heat exchanger to insure adequate time between successive defrost cycles for optimizing the efficiency and reliability of the system, or after a predetermined time interval has elapsed, whichever condition occurs first. During defrost cycle all compressors shall energize, and reversing valves shall de-energize.

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 that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.

5. Unit shall be provided with manual reset low temperature limit controls which shut off the unit when the discharge temperature reaches a field adjustable setpoint.

F. Supply Fans

1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.

2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.

3. Motors shall be inverter duty rated, 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.

G. Exhaust Fans

1. Exhaust dampers shall be sized for 100% exhaust air flow rate.

2. Fans and motors shall be dynamically balanced.

3. Motors shall be inverter duty rated, 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 handles.

5. Variable frequency drives shall be factory wired and mounted in the unit.

H. Evaporator Coil

1. Evaporator Coil

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 helium leak tested.

d. Coils shall be furnished with a factory installed thermostatic expansion valves.

I. Refrigeration System

1. Unit shall be factory charged with R-410A refrigerant.

2. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5 year warranty. Heating and cooling shall be provided by an airside heat pump system.

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 insulated 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 thermostatic 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 factory installed liquid line filter driers.

7. Unit shall include modulating capacity control through digital scroll compressors.

8. Unit shall include a variable capacity scroll compressor on the lead refrigeration

circuit(s) which shall be capable of modulation from 10-100% of its capacity.

9. Lead refrigeration circuit(s) shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.

10. Unit shall be configured as an air-source heat pump. Each refrigeration circuit shall each be equipped with a factory installed liquid line filter drier with check valve, reversing valve, accumulator, and thermal expansion valves on both the indoor and outdoor coils. Reversing valve shall energize during the heat pump heating mode of operation.

11. Each refrigeration circuit shall include adjustable compressor lockouts.

J. Remote Heat Pump

1. Remote Air-Cooled Heat Pump Unit

a. Heat Pump fans shall be vertical discharge, axial flow, direct drive fans.

b. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.

c. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

d. Coils shall be helium leak tested.

e. Heat pump fans shall be high efficiency electrically commutated motor (ECM) driven with factory installed head pressure control module. Heat pump airflow shall continuously modulate based on head pressure and cooling operation shall be allowed down to 35°F with adjustable compressor lockout.

K. Filters

1. Unit shall include 2 inch thick, pleated panel filters with an ASHRAE efficiency of 30% and MERV rating of 7, upstream of the cooling coil. Furnish a complete set of spare filters.

L. Demand Control Ventilation Components

1. Energy recovery ventilator fans shall be controlled by a variable frequency drive. Outdoor air and exhaust air fans shall be controlled simultaneously to maintain desired building pressure. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and exhaust air volumes are always maintained. The variable frequency drive shall be factory mounted in the

unit cabinet and wired.

2. Energy recovery ventilator shall be equipped with demand control ventilation capabilities that enable the varying of outdoor air and exhaust air volumes based on building occupancy. A sensor shall be located in the exhaust air stream and in the locations shown on the drawings to monitor average CO2 levels of the occupied spaces. A variable frequency drive shall receive a 0-10 volt signal from the CO2 sensor and control the outdoor air volume to maintain a maximum of 1,000 ppm of CO2 in the occupied space. Outdoor air and exhaust air fans shall be controlled simultaneously to maintain desired building pressure. Variable frequency drive shall be pre-programmed at the factory and shall assure that minimum outdoor air and exhaust air volumes are always maintained. The exhaust sensor and variable frequency drive shall be factory mounted and wired. The space CO2 sensors shall be field installed and field wired.

3. Furnish each energy recovery ventilator with the following:

   a. Supply air fan variable frequency drive.
   b. Exhaust air fan variable frequency drive.
   c. Carbon Dioxide (CO2) Sensor.
   d. Furnish one unit with additional outside air carbon dioxide (CO2) sensor to display ambient CO2 levels. (Interlock with ATC system.)

M. Energy Recovery

1. Unit shall contain a factory mounted and tested energy recovery wheel(s). The energy recovery wheel(s) shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frame shall slide out for service and removal from the cabinet.

2. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.

3. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.

4. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.

5. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel

rim drive without the need for external tensioners or adjustment.

6. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with *ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers* and *AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.*

7. Energy recovery wheel cassette shall carry a 5 year warranty.

8. Furnish spare energy recovery wheel belt.

9. Hinged service access door shall allow access to the wheel(s).

10. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.

N. Roof Curb

1. An insulated, pre-fabricated roof curb shall be provided and shipped knocked down. The roof curb will be made of 16 gauge galvanized steel with 4" flanges, minimum 14" high with a factory installed 2"x3" wood nailer strip. Curbs shall be fully insulated with 1 ½ inch thick rigid insulation with duct adapters.

2. Electrical shall enter unit concealed within roof curb. All piping within the unit enclosure shall be insulated with insulation type, thickness, and jacketing as specified in Division 23 Section, *HVAC Insulation*.

3. 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 ½ inch in height around the opening.

O. Controls

1. Factory Installed and Factory Provided Controller

a. Provide modular system manager for control of energy recovery ventilator at unit.

b. 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.

c. 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.

d. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.

e. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.

f. Modulating hot gas re-heat shall be supplied with a field installed supply air temperature sensor to control the amount of re-heating. Supply air temperature setpoint shall be field adjustable.

g. With the modulating hot gas reheat option a space humidity sensor and supply air temperature sensor shall be furnished with the unit for field installation. Suction pressure sensor shall be factory installed. Supply air temperature and space humidity setpoints, for the dehumidification mode of operation, shall be adjustable.

h. Outside air temperature sensor shall be factory mounted and wired. Supply air temperature sensor shall be furnished with the unit for field installation.

i. Furnish controls with the necessary interfaces to communicate via BACNET/IP or LonWorks to a building automation system.

j. All inputs and outputs on the manufacturer's controller shall be viewable via the interface.

k. All setpoints and schedules shall be editable via the interface by the Building Automation System.

l. In addition to standard inputs/outputs provide additional inputs/outputs as required to accomplish sequence of operation and items listed on point list.

m. The manufacturer shall be responsible for assisting and participating in the integration of the equipment into the Building Automation System and shall provide programming, testing, verification and on site personnel as required.

P. Unit Sequence of Operation

1. General

a. ERV supply fan and ERV exhaust fan shall be interlocked to operate

simultaneously.

b. When the ERV is de-energized, the outside air damper, (D-1) and exhaust air damper (D-2) shall close. The heat pump unit shall de-energize whenever the ERV fans are de-energized.

c. All dampers shall be provided with end switches to prevent operation of ERV supply fan and ERV exhaust fan until dampers are proved open.

d. The energy recovery unit shall operate with packaged controls to stage compressors and modulate compressor speed to provide heating/cooling. ATC subcontractor shall coordinate with energy recovery unit manufacturer's controller to provide all requirements, interlocks, relays, etc.

e. Furnish and install all interlock wiring to remote heat pump unit.

f. Furnish supply air and exhaust air variable frequency drives and carbon dioxide sensors to allow air flow modulation based on carbon dioxide levels.

g. All set point temperatures shall be resettable and adjustable through software. All temperature sensors shall be monitored.

h. A global outside air carbon dioxide sensor shall allow re-set of $C0_2$ sensor set points based on outside air CO_2 levels.

i. Field install space humidity and space temperature sensors for dehumidification and hot gas reheat control.

j. Provide differential static pressure sensors to determine filter loading of the ERV.

k. Field installed air flow monitoring station shall be provided for outside air supply duct.

2. Occupied Cycle:

a. The energy recovery ventilator fans and energy recovery wheel shall operate continuously to provide tempered, 100 percent outside air to the spaces.

b. The unit shall be arranged for a winter time morning warm-up cycle and a summer time morning pull down cycle (from 8:00 a.m. to 9:00 a.m.).

c. Morning warm-up cycle: During morning warm-up cycle, the outside air damper, (D-1), shall open and exhaust air damper (D-2) shall open. The energy recovery wheel shall rotate continuously. The unit fan shall operate in morning warm-up mode until the discharge air temperature (T-1) rises to 70 degrees F (adjustable). At that point the heat pump shall operate under

its packaged controls to provide heat in stages to maintain discharge air temperature at 72 degrees Fahrenheit.

d. Morning pull down cooling cycle: During morning pull down cooling cycle, the outside air damper (D-1) shall open and exhaust air damper (D-2) shall open. The energy recovery wheel shall rotate continuously. The packaged discharge air temperature controller (T-1) shall operate unit under packaged controls and energize the condensing unit to provide cooling in stages. The ERV shall remain in the morning pull down cycle until the discharge air sensed at T-1 drops to 78 degrees F (adjustable). The ERV shall then run continuously. Simultaneously, the condensing unit controller shall be placed under the control of the packaged discharge air temperature controller, (T-1). Upon completion of morning cool down period, the discharge air temperature controller, T-1, shall operate the unit cooling coil and hot gas re-heat coil to maintain space neutral (75 deg F, adjustable) discharge air conditions. A space humidity sensor shall override the discharge air temperature to provide dehumidification while providing hot gas re-heat.

e. Discharge air temperature (T-1) shall be resettable and adjustable through software.

f. Demand Controlled Ventilation: The main exhaust air stream prior to energy recovery wheel shall contain a CO2 sensor and select spaces will contain a CO2 sensor. CO2 sensors shall modulate the supply and exhaust air streams to maintain the CO2 level at 1,000ppm (adjustable). The minimum fan airflow rates shall be as scheduled. Set up and test minimum airflow rates with Test & Balance Engineer so that fans do not operate below minimum airflow rates regardless of measured CO2 levels. The CO_2 sensors shall modulate air flow rates in a linear fashion from minimum to maximum based on CO_2 measurements and re-set schedule. Coordinate with ATC Subcontractor. The CO2 sensor with the highest reading shall take priority control of fans using a discriminator control strategy.

3. Unoccupied Cycle:
   a. During the unoccupied cycle the supply fan and exhaust air fans shall be de-energized. Outside air damper (D-1), exhaust damper (D-2), shall close and the refrigerant system shall de-energize when the supply fan is turned off.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify all dimensions by field measurements. Verify that all equipment may be installed in accordance with pertinent codes and regulations, the original design, and the referenced standards.

B. Verify structure, mounting supports and membrane installations are completed to the proper

point to allow installation of roof mounted equipment, where applicable.

C. Examine rough-in requirements for all piping systems to verify actual locations of piping connections prior to installation.

D. Verify that electrical work installation is in accordance with manufacture's submittal and installation requirements of Division 26 sections. Do not proceed with equipment start-up until electrical work is acceptable to equipment installer. Coordinate sizes of all thermal overloads with Division 26.

E. Do not proceed until unsatisfactory conditions have been corrected.

F. Provide wiring diagrams of all equipment as specified in Division 23 Section, *Common Work Results for HVAC.*

3.2 GENERAL INSTALLATION REQUIREMENTS

A. Install all equipment in accordance with manufacturer's installation instructions, in accordance with state and local code requirements, and in accordance with the contract drawings. Install all equipment plumb and level, to tolerances as required by the manufacturer of each item of equipment. Maintain manufacturer recommended clearances around and over all equipment.

B. Coordinate vibration isolation requirements with all equipment in accordance with Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment*.

C. Coordinate all electrical requirements with Division 26.

D. Coordinate all indoor and outdoor equipment pad locations and sizes with approved shop drawing submittals. Provide operating weights of equipment to Structural Engineer for review. Coordinate equipment pad locations and sizes with the Concrete Contractor or General Contractor. Furnish anchor bolts which are to be inserted in concrete pads to concrete installer.

E. Verify piping arrangements of all equipment with the contract drawings. Piping details shall be strictly adhered to concerning valves, fittings, components, etc. At coils, where a rebuildable and repairable autoflow valve is installed in the line without the need for draining or shutting of the water, the same may be utilized as the isolation valve and additional shut-off valve is not required.

F. Connect all equipment, devices and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

G. Testing: After installing HVAC equipment, devices and components and after electrical circuitry has been energized, demonstrate product capability and compliance with

requirements.

H. Remove and replace malfunctioning units with new units and retest.

I. All mechanical penetrations or terminations in exterior walls shall be flashed and caulked watertight.

J. Arrange for equipment such as energy recovery units, heat pumps to be shipped to project in modules where space constraints require the same. Field erect components as required.

3.3 FIELD QUALITY CONTROL

A. Where indicated provide the services of a factory authorized service representative to examine the field assembly of components, installation, piping, electrical connections, controls, and clearances. Submit factory start-up check list to Engineer for information purposes. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

B. Where factory start-up of equipment is not specified, provide field start-up by qualified technician to examine the field assembly of components, installation, piping, electrical connections, controls and clearances. Record equipment manufacturers standard start-up information and submit to Engineer for review. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer, and forwarded to Testing and Balancing Agency.

C. Charge all refrigerant systems with refrigerant and oil and test for leaks. Repair leaks and replace lost refrigerant and oil.

D. Fill all hydronic systems with water and/or antifreeze (when required after flushing and test for leaks. Repair leaks and replace lost water and/or antifreeze. Coordinate with water treatment contractor.

E. Submit to Engineer a written table of all relief valve and make-up water valve settings for each system. Provide an additional copy in the Operations and Maintenance Manuals.

F. Verify proper motor sizes, voltages, thermal overloads, nameplate data, etc. All equipment voltages and current shall be recorded to insure that motors are operating below their service factors. Test and Balance Engineer shall record electrical data before continuous or permanent operation.

3.4 DEMONSTRATION

A. Where indicated, provide the services of a factory authorized service representative to provide start-up and to demonstrate and train the Owner's maintenance personnel.

B. Place equipment into operation and adjust controls and safeties. Replace damaged or malfunctioning components and controls.

C. Training:

1. Train the Owner's maintenance personnel on start-up and shut-down procedures, trouble shooting procedures, lubrication, servicing procedures and preventative maintenance schedules/procedures. Review with the Owner's personnel, the contents of the operation and maintenance data specified in Division 23 Section, *Common Work Results for HVAC.*
2. Submit operation and maintenance data as soon as possible prior to project close-out. Operations and maintenance data shall be submitted to the Owner for review and comment prior to submission to the Engineer.
3. Schedule training with the Owner through the Architect and/or Engineer with at least seven (7) days prior notice.

D. Contractor shall demonstrate removal and replacement of filters at all pieces of equipment with filters in the prescence of the Owners representative.

3.5 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

B. Clean fan and equipment interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils' entering air face.

3.6 FAN INSTALLATION REQUIREMENTS.

A. Install fans with resilient mounting and flexible electrical leads.

B. Install flexible connections and vibration isolators as specified in Division 23 Section, *Common Work Results for HVAC* and Division 23 Section *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment*. Ensure metal band of connectors are parallel with minimum one inch flex between ductwork and fan while running.

C. Provide safety screens/guards on all fans and permanently mount after final testing and balancing.

D. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fans have been test run under operation.

E. Provide sheave required for final air balance.

F. Install fans according to manufacturer's written instructions.

G. Adjust damper linkages for proper damper operation.

H. Adjust belt tension.

I. Lubricate bearings.

J. Replace fan and motor pulleys and belts as required to achieve design conditions.

3.7 HVAC PUMP INSTALLATION REQUIREMENTS

A. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

B. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over.

C. Provide air cock and drain connection on horizontal pump casings.

D. Provide drains for bases and seals, piped to and discharging into floor drains.

E. Check, align, and certify alignment of base mounted pumps prior to start-up. Prior to starting pumps, the alignment of the pumps and their motors or other drivers shall be carefully checked. Alignment should be checked for both offset and angularity. Alignment by means of an Ames dial, Laser or equivalent shall be accomplished for all pumps. Alignment by straight edge across the pump couplings shall not be acceptable.

F. Install base mounted pumps on concrete housekeeping pads, with anchor bolts, set and level, and grout in place. See Division 23 Section, *Vibration Controls for HVAC, Plumbing and Fire Protection Equipment* for inertia pad requirements. After alignment is correct, tighten foundation bolts evenly but not too firmly, completely fill baseplate with non shrink, non metallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.

G. Lubricate pumps before start-up.

H. Install pumps according to manufacturer's written instructions.

1. Install pumps according to HI 1.1-1.5, *Centrifugal Pumps for Nomenclature, Definitions, Application and Operation.*

I. Install pumps to provide access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

J. Suspend in-line pumps using continuous-thread hanger rod and vibration-isolation hangers.

K. Set base-mounted pumps on concrete foundation. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.

1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges

with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

2. Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and suction and discharge flanges of pump to verify that they are level and plumb.

3.8 WATER TREATMENT INSTALLATION REQUIREMENTS

A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.

B. Place terminal control valves in open position during cleaning. Open bypass valves on coils and close isolation valves on coils during initial flushing.

C. Verify that electric power is available and of the correct characteristics.

D. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect.

E. Flush open systems and closed systems with clean water for one hour minimum. Drain completely and refill.

F. Remove, clean, and replace strainer screens.

G. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.9 ENERGY RECOVERY VENTILATOR INSTALLATION REQUIREMENTS

A. Examine areas to receive energy recovery units for compliance with requirements for installation tolerances and other conditions affecting performance of energy recovery units. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Install energy recovery units as indicated, according to manufacturer's written instructions.

C. Install CO2 sensor/control/interlock wiring to variable frequency drives and to ATC system. Install global CO2 sensor to monitor ambient outside air CO2 level.

D. Install and interlock high density space CO2 sensors.

E. Install heat wheels so supply and exhaust flow in opposite directions and rotation is from exhaust side to purge section to supply side.

1. Provide access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.
2. Provide removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.

F. Install and interlock outside air flow monitoring station.

G. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

H. Ducts and fan installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

I. Ground Equipment

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

J. After completing system installation, including outlet fittings and devices, inspect and clean exposed finishes. Remove dirt and construction debris and repair damaged finishes.

K. Startup Services: Engage a factory-authorized service representative to commission units as specified below.

1. Energize and verify correct rotation of heat wheels and fans.
2. Adjust seals and purge.
3. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
4. Verify sequence of operation.
5. Record fluid temperatures and flow rates.

L. Training

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventative maintenance.
2. Review data in the operation and maintenance manuals. Refer to Division 01 Section, *Demonstration and Training.*
3. Schedule training with Owner, through Architect, with at least 7 days advance notice.

END OF SECTION

DIVISION 23 SECTION 230701
HVAC INSULATION

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SECTION 230701 - HVAC INSULATION

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2. REFERENCE

A. The Conditions of the Contract and other General Requirements apply to the work specified in this Section. All work under this Section shall be subject to the requirements of Division 23 Section, *Common Work Results for HVAC*.

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

1.3. DESCRIPTION

A. All piping, ductwork and equipment installed under this Contract shall be covered as specified.

1.4. SCOPE

A. The work covered by this specification 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 all piping, equipment, and duct systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

1.5. STANDARDS

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 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation".
b). ASTM C 533, "Standard Specification for Calcium Silicate Pipe & Block Insulation".
c). ASTM C 55, "Standard Specification for Mineral Fiber Blanket and Felt Insulation".
d). ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)".
e). ASTM C 612, "Standard Specification for Mineral Fiber Block and Board Thermal Insulation".
f). ASTM C 1136, "Standard Specification for Barrier Material, Vapor, "Type 1 or 2 (Jacket only).
g). ASHRAE 90.1 "Energy efficient design of new buildings except low-rise residential buildings", latest edition.

B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.6. 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) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, (latest edition) and "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), latest edition. 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. As minimum, all insulation thicknesses shall be as hereinafter specified.

B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:

1.	American Society for Testing of Materials	ASTM E 84
2.	Underwriters' Laboratories, Inc.	UL 723
3.	National Fire Protection Association	NFPA 255

C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos-free characteristics.

1.7. 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.

C. Mockups:
Provide at project site a sample of each type of insulation hereinafter specified. Display insulation in an "installed" condition, showing typical completed pipe, covers, fittings, ductwork and equipment insulation. No insulation shall be applied until these samples have been accepted by the Engineer. Any insulation work which does not conform to the accepted samples will not be acceptable, and shall be removed and re-installed in a manner acceptable to the Engineer at no additional cost to the Owner. Build mockups according to the following requirements, using materials indicated for the completed work.

1. Include the following pipe insulation mockups:

   a). Exterior aluminum jacketing
   b). One 10-foot section of NPS 2 inch straight pipe.
   c). One 90-degree elbow.
   d). One tee fitting.
   e). One NPS 2 inch valve.
   f). Four support hangers, including hanger shield and insert.
   g). One strainer with removable portion of insulation.
   h). One reducer.

2. Include the following equipment insulation mockups:

   a). One small tank or vessel.
   b). One geothermal centrifugal pump.
   c). One plumbing pump/circulator.

3. Include the following duct insulation mockups:

   a). One 10 foot section of rectangular straight duct.
   b). One 90 degree square elbow and one 90 degree radius elbow.
   c). One branch takeoff.
   d). One transition fitting.
   e). Four support hangers.

4. Mockups shall include samples of both concealed insulation and exposed insulation.

5. Build mockups with cutaway sections to allow observation of application details for insulation materials, mastics, attachments, and jackets.
6. Build mockups in the location indicated or, if not indicated, as directed by Engineer.
7. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
8. Obtain Engineer approval of mockups before starting insulation application.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
10. Demolish and remove mockups when directed.
11. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

1.8. 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 in writing for technical assistance.

D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements. Protect all insulation from water, construction traffic, dirt, chemical and mechanical damage.

1.9. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.10. LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2. PRODUCTS

2.1. GENERAL

A. All materials to be insulated shall be thoroughly cleaned, after completion of successful tests, and shall be covered as specified below. Fiberglass insulation shall be Owens-Corning, Manville, Armstrong, or P.P.G, or as approved equal.

2.2. PIPE INSULATION MATERIALS

A. Unless otherwise noted, insulation shall be one piece or half sectional molded fibrous glass with "K" rating of .23 at 75 degrees Fahrenheit mean temperature, for service temperatures between -60 degrees Fahrenheit and +450 degrees Fahrenheit with all service jacket. Pipe insulation shall be fiberglass SSL II with double closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.

B. Exterior refrigerant pipe insulation shall be Armaflex, or approved equal, foam insulation with exterior field applied aluminum jacketing. Interior refrigerant piping shall be Armaflex or approved equal foam insulation. Where interior refrigerant piping is exposed also install field applied PVC jacketing.

C. Unless otherwise noted, pipe insulation jacket shall be factory-applied vinyl coated, embossed and reinforced vapor barrier laminate, with a perm rating of not more than 0.02 perms. All hot and cold, concealed and exposed butt strips shall be of the same material as the jacket. Jacket and butt strips shall be sealed with field-applied Benjamin Foster adhesive. Jacket and butt strips shall be off-white color and shall be equivalent to Owens-Corning Fiberglass 25-ASJ.

D. For fittings on all piping, valves and flanges, apply fiberglass molded or segmented insulation equal in thickness to the adjoining insulation and securely fasten in place using wire. Apply a skin coat of insulating cement to produce a smooth surface. After cement is dry, apply a light coat of fitting mastic, UL labeled, Type C, for cold water piping, and Type H for hot water piping. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of Type C or Type H mastic over the reinforcing cloth, working it to a smooth finish. As an option to the above fittings, a polyvinyl chloride fitting cover may be supplied.

E. All pipe insulation, jackets, or facings, and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 225, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Accessories such as adhesives, mastic cements, tapes and cloth for fittings shall have the same ratings as listed above. All products or their shipping cartons shall bear the Underwriter's label indicating that flame and smoke ratings do not exceed the above criteria.

F. For piping having a vapor barrier insulation and for all insulated piping requiring supports, hangers and supports shall be installed outside the insulation. Wherever hangers and

supports are installed outside the insulation, pipe insulation protecting shields shall be provided. Where insulation is a load bearing material, of sufficient strength to support the weight of the piping, pipe shields one-third the circumference of the insulation and of a length not less than three times the diameter of the insulation (maximum length 24-inches) shall be provided. Insulation of 7-1/4 pound or greater density will be considered as load bearing for pipe sizes up to and including 2-inches. Where insulation is not of sufficient strength to support the weight of the piping, a half section of high density fiberglass or foam inserts, shall be provided. Vapor barrier and finish shall be applied as required to match adjoining insulation. In addition, shields shall be furnished as specified above.

G. For piping located outside of the building, an corrugated aluminum weatherproof jacketing system shall be provided. This system shall be Micro-Lot ML as manufactured by Manville, Polyweld by Pabco Metals Corp., Childers, or as approved equal, and installed per the manufacturer's recommendations. Pipe jacketing shall be corrugated (3/16-inch) deep aluminum, .016-inch thickness of H-14 temper with aluminum strapping of .75-inch width and .020 inch thickness with moisture barrier. Aluminum jacketing elbows shall be smooth, .016-inch thickness and 1100 alloy. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation. Longitudinal joints shall be applied so they will shed water and shall be sealed completely. Circumferential joints shall be closed using preformed butt strips following manufacturer's recommendations for securement. Jacket seams shall be located on the bottom side of the horizontal piping.

H. On cold systems such as refrigerant piping, cooling coil drains, geothermal heat pump piping, etc. vapor barrier performance is extremely important. All penetrations of the ASJ and exposed ends of insulation must be sealed with vapor barrier mastic. The ASJ must be protected with either a mastic coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion.

I. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings. Where applicable, Victaulic PVC fitting valve and coupling covers shall be utilized. Victaulic PVC covers shall be installed with matching pipe insulation jacketing material, vinyl tape solvent weld adhesive and appropriate fasteners.

1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor-resistant mastic as dictated by the system location and service. Finish valve installation with a Tyvac jacket with ends that secure to adjacent piping.
2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.
3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems must be sealed with

caulking which allows free movement of the stem but provides a seal against moisture incursion. All gauge and thermometer penetrations and extensions shall be correctly sealed and insulated to prevent surface condensation.

J. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.

1. Piping systems 3-inches (7.5cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation. Hangers saddles shall be minimum 16 gauge with a saddle arc of 120 degrees minimum.
2. For hot or cold piping systems larger than 3-inches (7.5 cm) in diameter, operating at temperatures less than +200 degrees F (93 degrees C) and insulated with fiber glass, high density inserts such as foam with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding $\pm$200 degrees F (93 degrees C), Owens-Corning Pink Calcium Silicate pipe insulation shall be used for high density inserts.
3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7kg/cm).
4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
5. Thermal expansion and contraction of the piping and insulation system shall generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.
6. On vertical runs, insulation support rings shall be used.

2.3. PIPING INSULATION THICKNESSES SCHEDULE

A. All piping shall be insulated with pipe insulation of the thicknesses indicted below:

PIPING INSULATION THICKNESS SCHEDULE SERVICES	**THICKNESS**
Interior Geothermal Piping, Including Chemical Treatment Piping	1 ½ -inch thickness
Direct Buried Geothermal Exterior Piping	Refer to Div. 2
All Drain Piping from Cooling Coils/Evaporators	½-inch thickness
Chemical Feed System	1-inch thickness

PIPING INSULATION THICKNESS SCHEDULE SERVICES	**THICKNESS**
All Above Grade Floor Drain Piping Serving AHU Condensate Drains include Drain Sumps and Auxiliary Drain Pipes from Auxiliary Pans	1-inch thickness
All Refrigerant Piping	1 ½ -inch thickness

2.4. EQUIPMENT INSULATION MATERIALS AND THICKNESSES

A. The following equipment shall be insulated with Fiberglass Rigid Board Insulation or Foam Plastic Insulation:

1. Geothermal Pump Bodies.
2. Air Separators.
3. Expansion Tanks.
4. Chemical Feed Tanks.
5. Freeze Protection Pump Bodies.
6. All Pump Volutes and Strainers.

B. Insulation for cold surfaces shall be 1-1/2-inch thickness, 6 lb. density, 705 FRK with a "K" rating of .23 at 75 degrees F mean temperature. Insulation for hot surfaces except as otherwise noted shall be 1-1/2-inch thickness, 6 lb. density, 705 with a "K" rating of .23 at 75 degrees F mean temperature. Insulation shall be applied with staggered joints firmly butted and joined. The insulation shall be held in place by steel bands. Bands shall be 1-inch by 25 gauge galvanized steel spaced on not over 12-inch centers. All joints and voids shall be filled with Owens-Corning #110 cement, well troweled into openings. For 705 FRK insulation, all joints and voids shall be FRK taped and vapor sealed. There shall be applied over the insulation surface 1-inch 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 2-inch thick layer of Owens-Corning #110 cement applied in two layers. Install metal corner beads at all corners and edges in order to provide a permanent installation. Onto the dry cement surface apply a brush coat of Foster Sealfas 30-36 at the rate of 60-70 square feet per gallon. Embed into wet coating a layer of 8 ounce canvas 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. Cleanouts, nameplates, and manholes shall not be insulated, and the insulation on surrounding surfaces shall be neatly beveled off at such openings.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.

2. Fabricate boxes from aluminum at least 0.040 inch (1.0 mm) thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

D. Mechanical fasteners shall be utilized to hold insulation to surface with bands as required to hold the curvature of the material.

E. Support rings shall be provided to support the top head insulation where required.

F. Outdoor installations require a weather barrier for protection of the insulation jacketing.

G. Insulation types materials shall be suitable for temperatures encountered by each item of equipment.

2.5. DUCTWORK INSULATION MATERIALS AND THICKNESSES

A. Insulate all supply, return, relief, combustion air, plenums, discharge, exhaust, (for ERV projects) and outside air intake ductwork with fiberglass exterior duct insulation with factory-applied foil facing. All exposed fiberglass duct insulation shall be 1-1/2-inch rigid or non-flexible board type 3.0 pcf minimum density, 0.23 max. "K" factor at 75 degrees F mean temperature, with white vinyl A.S.J. vapor barrier facing. All concealed fiberglass duct insulation shall be 1-1/2-inch flexible blanket type, 1.0 pcf minimum density. All concealed insulation shall be 0.27 max. "K" factor at 75 degrees F mean temperature with reinforced foil-scrim Kraft vapor barrier facing.

B. Refer to Division 23 Section, *HVAC Air Distribution System* and contract drawings for location of all sound-lined ductwork. Sound-lined ductwork from the discharge or supply side of all air handling units, energy recovery units, and heat pumps, shall require external insulation in addition to internal lining specified hereinafter. All other ducts indicated to be provided with interior lining shall not require additional exterior insulation.

C. Where a vapor barrier is required, all joints, seams, tears, punctures, and other penetrations shall be closed with 3-inch (7.5cm) pressure-sensitive tape matching the facing or with vapor barrier mastic reinforced with 3-inch (7.5cm) glass scrim tape.

D. Exposed dual wall ductwork located in finished areas shall not require additional exterior insulation. Exposed dual wall supply ductwork located in mechanical room, shall require additional rigid exterior insulation as hereinafter specified.

E. Contractor-applied internal linings shall be as specified and installed as hereinafter specified.

F. For exposed Fiberglass duct insulation, tightly butt all edges and seams. Secure insulation with flush mechanical fasteners spaced not less than one per square foot. Insulation may be secured with 100 percent coverage of adhesive with mechanical fasteners on the underside of the duct only, in addition to adhesive. Cover all seams, joints and fasteners with not less than 3-inch wide tape matching the insulation facing. Pre-finished white fastener caps may be left exposed if the spacing and pattern is uniform in appearance. Staples will not be permitted.

G. All supply air diffusers and supply air registers shall be fully insulated on the rear exposed surface to prevent condensation. Insulation shall be 1 ½" inch flexible blanket type 1 ½ pcf minimum density with reinforced foil-scrim-Kraft vapor barrier facing, .25 max "k" factor.

H. All airflow monitoring stations shall be externally insulated similar to adjacent ductwork as hereinbefore specified.

2.6. ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under this section shall include, but not be limited to:

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.
2. Field-applied jacketing materials - sheet metal, plastic, canvas, fiber glass cloth, insulating cement; PVC fitting covers, PVC jacketing.
3. Support Materials - Hanger straps, hanger rods, saddles.
4. Fasteners, weld pins/studs, speed clips, insulation washers.
5. Metal mesh or expanded metal lagging.

B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Insulation Standards."

2.7. FIELD-APPLIED JACKET (ALTERNATE)

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

a). Johns Manville; Zeston.
b). P.I.C. Plastics, Inc.; FG Series.
c). Proto PVC Corporation; LoSmoke.
d). Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

a). Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.

PART 3. EXECUTION

3.1. WORKMANSHIP

A. The Contractor shall take special care to prevent soiling equipment below or adjacent to areas being insulated. He shall be completely responsible for removing insulation cement splashes and smears and all surfaces that he mars or otherwise soils or defaces, and he will be totally responsible for restoring these damaged surfaces to their like-new condition when delivered to the site.

3.2. SITE INSPECTION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.3. PREPARATION

A. Ensure that all pipe and equipment surfaces over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping or duct systems has been completed prior to installing insulation.

3.4. INSTALLATION

A. Piping Systems

1. General:

a). Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
b). Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.
c). Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
d). Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tear or other damage. Seal all tears, punctures and other penetrations of the pipe insulation vapor barrier facing.
e). On exposed piping, locate insulation and cover seams in least visible location.

2. Fittings: Cover valves, fittings, unions, flanges, strainers, flexible connections, expansion joints, pump bodies, strainers, blowdowns, backflow preventers, autoflow valves and similar items in each piping system using one of the following:

a). Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.
b). Insulation cement equal in thickness to the adjoining insulation.
c). PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.

3. Penetrations: Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.
4. Joints:

a). Butt pipe insulation against hanger inserts. For hot pipes, apply 3-inch (7.5cm) wide vapor barrier tape or bank over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3-inch (7.5cm) wide vapor barrier tape or band.
b). All pipe insulation ends shall be tapered and sealed, regardless of service.

B. Equipment Insulation:

1. General:

a). Install insulation in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.

b). Install insulation on equipment after installation of heat tracing, painting, testing, and acceptance tests.

c). Install insulation materials with smooth, even surfaces. Rework poorly fitted joints. Do not use joint sealer or mastic as filler for joint gaps and excessive voids resulting from poor workmanship. Apply insulation using staggered joint method for both single and double layer installation, applying each layer of insulation separately.

d). Coat insulated surfaces where specified on contract drawings with layer of insulating cement, troweled in a workmanlike manner, leaving a smooth and continuous surface. Fill in seams, broken edges, and depressions. Cover over wire mesh and joints with cement sufficiently thick to remove surface irregularities.

e). Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. Seal all tears, punctures and other penetrations of equipment insulation facing.

f). Where specification calls for field-applied all-service vapor barrier jacketing, it shall be neatly fitted and tightly secured. Lap seams 2-inches (5cm) (min.). Seal all joints with adhesive. Tape with 3-inches (7.5cm) matching pressure-sensitive tape or 3-inch (7.5cm) glass fabric and mastic.

g). On exposed equipment, locate insulation and cover seams in least visible location.

2. Removable Insulation: Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance, such as vessel covers, fasteners, flanges, frames accessories, manholes, handholes, cleanouts ASME stamp, and manufacturer nameplates.

3. Areas Left Uninsulated: Items such as handholes, clean-outs, ASME stamp, and manufacturers' nameplates should be left uninsulated unless omitting insulation would cause a condensation problem. When such is the case, provide removable insulation and appropriate tagging to identify the presence of these items. Provide neatly beveled edges at interruptions of insulation.

4. Equipment Exposed to Weather: Protect outdoor insulation from weather by installation of weather barrier mastic protective finish or jacketing as recommended by the jacketing manufacturer.

C. Ductwork Insulation:

1. General:

a). Before installing insulation, ensure that all seams and joints in ductwork have been sealed and leak tested by the contractor responsible for the duct system. Before applying duct insulation, air ducts shall be clean and dry.

b). Install insulation in accordance with manufacturer's published instructions and recognized industry practice to ensure that it will serve its intended purpose.

c). Install insulation materials with smooth and even surfaces. Butt joints firmly together to ensure complete and tight fit over surfaces to be covered.

d). Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. All staples

used on ductwork insulation shall be coated with suitable sealant to maintain vapor barrier integrity and covered with pressure sensitive vapor barrier tape.

e). Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and exposed joints. All portions of duct designated to receive duct wrap shall be completely covered with duct wrap.

f). To ensure installed thermal performance, duct wrap insulation shall be cut to "stretch-out" dimensions. Maintain specified duct insulation thickness and vapor barrier at all fittings, obstructions, and duct flanges.

g). A 2-inch (50mm) piece of insulation shall be removed from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.

h). Install duct wrap insulation with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted with the 2-inch (50mm) stapling and taping flap overlapping. If ducts are rectangular or square, install so insulation is not excessively compressed at corners. Seams shall be stapled approximately 6-inches (150mm) on center with 2-inch (13mm) (min) steel outward clinching staples.

i). Seams, joints and staples shall be sealed with pressure-sensitive tape matching the insulation facing (either plain foil or FRK backing stock) or glass fabric and mastic. Cloth duct tape of any color or finish using reclaimed rubber adhesives shall not be utilized on duct wrap insulation. Adjacent sections of duct wrap shall be tightly butted with the 2-inch (50mm) tape flap overlapping.

j). Where rectangular ducts are 24-inch (600mm) in width or greater, duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18-inch (425mm) centers (maximum) to prevent sagging of insulation.

k). Seal all tears, punctures and other penetrations of the duct wrap facing using one of the above methods to provide a vapor tight system.

l). Upon completion of installation of duct wrap and before operation is to commence, visually inspect the system and verify that it has been correctly installed.

m). Open all system dampers and turn on fans to blow all scraps and other loose pieces of material out of the duct system. Allow for a means for removal of such material.

n). Check the duct system to ensure that there are no air leaks through joints.

o). No ductwork insulation shall be supported utilizing tie wire or bailing wire. Penetrations of ductwork insulation vapor barrier are prohibited.

p). Bevel and terminate insulation at access doors. Paint edges with vapor barrier mastic.

q). Install insulation board between volume dampers and sheet metal standoffs.

r). Provide removable insulation section at all pitot tube traverse points. Insulation section shall contain tether that attaches to adjacent ductwork.

2. Penetrations: Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise specified.

3. Ductwork Exposed to Weather: Protect outdoor insulation from weather by installing outdoor protective finish or jacketing as recommended by the insulation manufacturer.
4. Rigid Insulation:

    a). Rigid duct insulation may be impaled over welded pins and secured with insulation caps and washers matching the color of the vapor barrier facing. All seams shall be firmly butted and sealed with pressure-sensitive vapor barrier tape matching the facing.
    b). Corner angles shall be installed on all external corners of rigid duct insulation in exposed finished areas before jacketing, except oven and hood exhaust duct insulation, which shall have no corner angles.

5. Duct Wrap Insulation: Duct wrap insulation shall be applied with all joints butted firmly together. All joints in the insulation covering shall be sealed with adhesive. Duct wrap insulation shall be secured to bottom of rectangular or oval ducts over 24inches (60cm) wide with mechanical fasteners on 16-inch (40 cm) (approx.) centers to prevent sagging.
6. Duct Lining Insulation: Duct liner insulation shall be applied with all joints tightly butted using 90 percent coverage of adhesive meeting the requirements of ASTM C 916 plus mechanical fasteners spaced according to the liner manufacturer's schedule for the interior width of the plenum, housing, or air shaft. (Also refer to Division 23 Section, *HVAC Air Distribution System*.)

3.5. FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.6. PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.7. SAFETY PRECAUTIONS

A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials, and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.8. INSULATION COVERING (ALTERNATE)

A. Unless otherwise noted, all exposed duct and equipment insulation shall have a field applied PVC jacket cover neatly cut and pasted over ,ductwork and equipment insulation. PVC shall be color coded by system and shall be 30 mils thick.

B. Unless otherwise noted, all exposed pipe insulation required to be insulated shall be jacketed with a PVC Jacketing with fitting covers. PVC jacket shall be color fade resistant, color coded, U.S.D.A. authorized as manufactured by Proto Corporation or approved equal. PVC jacketing shall be high impact, ultraviolet resistant PVC. Minimum thickness shall be 30 mils, roll stock ready for shop or field cutting and forming. Suggested color coding shall be as follows:

1. Geothermal HPWS, HPWR Piping – Light Blue
2. Refrigerant Piping – Green

All colors shall be in accordance with ANSI Standards. Submit color coding for review and approval.

C. Exposed areas include, but are not limited to, all mechanical equipment rooms/fan rooms, electric rooms, and piping and ductwork exposed in an occupied space.

D. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints, for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.9. EXTERIOR INSULATION COVERING (BASE BID)

A. Exterior exposed pipe insulation required to be insulated shall be jacketed with a corrugated aluminum jacketing system as previously described.

END OF SECTION

DIVISION 23 SECTION 230900
INSTRUMENTATION AND CONTROLS OF HVAC AND PLUMBING SYSTEMS (DDC SYSTEM)

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SECTION 230900 - INSTRUMENTATION AND CONTROLS OF HVAC AND PLUMBING SYSTEMS (DDC SYSTEM)

PART 1. GENERAL

1.1. RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements", and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers, and suppliers.

1.2. SUMMARY

A. For General Mechanical Requirements, see Division 23 Section, *Common Work Results for HVAC*, and Division 01 Sections.

B. Comply with all code requirements and fire safety requirements as specified in Division 23 Section, *Common Work Results for HVAC*.

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

D. 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. Furnish all testing, verification, and programming of all controls.

E. The automatic temperature control system ATC and central control and monitoring system (CCMS) shall be electric/electronic direct digital control (DDC), Alerton, Johnson Controls (Metasys), Honeywell, Invensys, Siemens, Automated Logic Corporation. Control Technologies shall be an acceptable installer of the ATC system. All work associated with the automatic temperature control system shall be performed by personnel regularly and directly employed by the Automatic Temperature Controls Contractor. Control System shall be web based, allowing the client access via a standard web browser.

F. Coordinate controls with controlled equipment. Upon completion of the work, calibrate and adjust all controls for proper function. Electric wiring, including interlock wiring for equipment such as carbon dioxide sensors, temperature sensors, fans, switches, heat pumps, ERV's, pumps, variable refrigerant volume systems, etc., shall be furnished and installed under this section. All electrical work shall conform to the applicable requirements of Division 26.

G. Interlock all packaged controls with ATC system. Furnish and install graphical monitoring screens, schedules, trends, sensors, items on product list and alarms consistent with College standards.

H. All automatic temperature control dampers, valves and separable wells for immersion elements furnished by the Control Manufacturer shall be installed by the Mechanical Contractor or his sheet metal subcontractor under the Control Manufacturer's supervision.

I. Reference is hereby made for this contractor to become familiar with Division 26 of these specifications. Familiarization is for coordination purposes only. The control contractor shall provide all necessary relays, contacts, interlock wiring etc. not provided under Division 26 for the automation of the ATC and CCMS systems as required by the sequence of operation and input/output schedule. The control contractor shall coordinate all requirements with the building Fire Alarm System. The control contractor shall provide all additional devices and interlock wiring required for the automation of the ATC system and monitoring of the CCMS system.

J. Furnish all labor, materials, software, equipment and services necessary for and incidental to furnishing and installing a complete direct digital control, automatic temperature control system to meet the requirements of the sequence of operation described in Part 4.

K. Unless the necessary items are specified to be provided with mechanical equipment by Division 23, the ATC contractor shall coordinate with Division 23, Mechanical, and shall furnish and install all items necessary to meet the requirements of the Sequence of Operation and the Central Control and Monitoring System (CCMS) indicated on the drawings and as required in this specification.

L. The control system shall include all necessary and specified control equipment properly installed in accordance with the specifications and drawings and shall include, but not be limited to the automatic temperature control and energy management system of the following:

1. Airflow Monitoring Stations
2. Building Demand and Energy Consumption
3. Canopy Hoods
4. Domestic Hot Water Systems
5. Domestic Water Consumption
6. Ductless Units
7. Energy Recovery Ventilators
8. Flow Measuring Stations
9. General Exhaust Systems
10. Geothermal Heat Pumps
11. High Temperature Alarms
12. Make-up Water Systems Interlocks and Alarms
13. Plumbing Systems
14. Pumps
15. Solar Photovoltaic System
16. Thermal Solar System
17. Variable Speed Drives
18. Variable Refrigerant Volume Systems

M. All labor, material, equipment and software to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be included. Drawings are

diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that are required to meet the functional intent, shall be provided without additional cost to the owner.

1.3. DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

H. UPS: Uninterruptible Power Supply.

I. NAE: Network Automated Engine.

1.4. SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

1. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
2. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
3. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
4. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
5. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
6. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
7. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:

a). Water Temperature: Plus or minus 1 deg F (0.5 deg C).
b). Water Flow: Plus or minus 5 percent of full scale.
c). Water Pressure: Plus or minus 2 percent of full scale.

d). Space Temperature: Plus or minus 1 deg F (0.5 deg C).
e). Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
f). Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
g). Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
h). Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
i). Relative Humidity: Plus or minus 5 percent.
j). Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
k). Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
l). Airflow (Terminal): Plus or minus 10 percent of full scale.
m). Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
n). Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
o). Carbon Monoxide: Plus or minus 5 percent of reading.
p). Carbon Dioxide: Plus or minus 50 ppm.
q). Electrical: Plus or minus 5 percent of reading.

1.5. 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.

1.6. COORDINATION

A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 Section, *"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 Division 26 Section, *Electricity Metering* to achieve compatibility of communication interfaces.

E. Coordinate equipment with Division 26 Section, *Panelboards* to achieve compatibility with starter coils and annunciation devices.

F. Coordinate equipment with Division 26 Section, *Motor-Controllers* to achieve compatibility with motor starters and annunciation devices.

1.7. WORK BY OTHERS

A. Automatic temperature control valves, air flow stations, pipe taps, flow meters, and

separable wells for immersion elements furnished by the control manufacturer shall be installed by the mechanical contractor under the control manufacturer's supervision. The control contractor shall deliver to the mechanical contractor valves and wells for installation within the various systems.

B. All automatic dampers furnished by the control manufacturer shall be installed by the mechanical contractor under the control manufacturer's supervision.

1.8. QUALITY ASSURANCE

A. The automatic temperature control (ATC) system and the central control and monitoring system (CCMS) shall be as manufactured by Johnson Controls, Honeywell, Siemens, Alerton, Invensys, or Automated Logic Corporation. Control Technologies shall be an acceptable installer of the ATC system.

B. Supplier shall have an in-place support facility with technical staff, spare parts inventory and all necessary test and diagnostic equipment. The fully staffed and equipped office shall be within a 60 mile radius of the job site.

C. The systems shall be complete in all respects, and shall be installed by skilled personnel. The Control Contractor shall have a successful history in the installation and maintenance of automatic temperature control systems similar in size and performance to that specified herein.

D. All electrical wiring in connection with the Automatic Temperature Control System shall be furnished and installed by the ATC Contractor. This shall include all interlock wiring between the air handling units, fans, pumps, switches, dampers, heat pumps, energy recovery ventilators, geothermal units, ductless units, condensing units, and variable refrigerant volume systems, etc.

E. Bids by wholesalers, contractors or franchised dealers or any other firm whose principal business is not that of manufacturing or installing automatic temperature control systems, shall not be acceptable. Bid documents that are not complete in their response to these documents or take exception to any of the capabilities defined within these documents shall not be acceptable.

F. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

G. 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.

H. Comply with ASHRAE 135 for DDC system components.

1.9. GUARANTEE AND INSTRUCTION

A. The control system including all components, system software, parts and assemblies herein specified shall be free from defects in workmanship and materials under normal use and service. After completion of the installation, the Control Manufacturer shall regulate and adjust all thermostats, control valves, control motors, and other equipment provided under this contract. If within two (2) years from the date of acceptance by Owner any of the equipment herein described is proved to be defective in workmanship or materials, it will be replaced or repaired at no additional cost to the Owner. The Control Manufacturer shall, after completion, provide any service incidental to the proper performance of the Control System under guarantees outlined above for a period of two (2) years. Normal maintenance of the system is not to be considered part of the guarantee. All corrective modifications made during warranty service periods shall be updated on all user documentation including "as-built" shop drawings and on user and manufacturer archived software disks.

B. The control contractor shall completely check out, calibrate and test all connected hardware to insure that the system performs in accordance with the approved specifications and sequences of operation submitted.

C. Upon completion of the work, the control drawings encased in heavy plastic shall be provided where directed. Layout shall show all control equipment and the function of each item indicated.

D. The temperature control contractor's office shall be within a 100 mile radius of the job site.

E. The contractor shall respond to the job site with qualified technicians within a 4 hour period for any emergency relating to the control system or energy management systems.

F. This agreement shall include emergency service during normal working hours.

1.10. 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. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks or Bacnet.

D. 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.

E. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

F. Qualification Data: For Installer and manufacturer.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section, *Operation and Maintenance Data*, and Division 23 Section, *Common Work Results for HVAC* include the following:

1. Maintenance instructions and lists of spare parts for each type of control device.
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.

I. Upon completion of the work, provide a complete set of "as-built" drawings and application software on magnetic floppy disk media. Drawings shall be provided in format as acceptable to the Owner's files. Submit as-built drawings and specification to Owner's representative for review and approval prior to final project closeout.

J. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.11. SOFTWARE LICENSE AGREEMENT

A. The owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

B. Software license agreement shall not apply on projects where existing ATC system is being extended.

1.12. ELECTRICAL SURGE PROTECTION

A. It is the responsibility of the ATC/FMS contractor to provide adequate surge protection for all wall mounted control panels required for this project.

1. Devices under surge protection shall be of design that loss of memory will not

occur in the event of the surge protection device being activated due to surge/spike conditions.

2. Surge protection devices will be required to be hard wired, with the exception of peripheral devices that use standard 110VAC plugs for connections (i.e. Modems).
3. Surge protection devices are to be rated for 120 VAC single phase, 20 (or greater) amps capacity.
4. Surge Protection devices to internal fuse protection, audible surge alarm & LED indicators.
5. Surge protectors to have clamping voltage of 480V peak, maximum surge current rating of 50,000 amps. Unit to have NEMA 12 enclosure with wall mounting bracket and conduit connection.

1.13. TRAINING

A. The Automatic Temperature Controls (ATC) Contractor shall include in his bid, provisions for additional computer training at the company's regular school or training center. The ATC contractor shall include in his bid all costs associated with sending one (1) individual to the ATC contractors school for a period of not less than two (2) weeks. This training is in addition to the aforementioned training required under the General Provisions.

B. The training time period shall be coordinated with the school system's facility Engineer. The schedule training period shall be arranged at the owner's convenience.

C. Cost shall include all training material, instruction books, and two copies of video tape with sound DVD of training session.

D. Upon completion of the work, the Control Contractor shall have completely adjusted the entire control system. He shall arrange to instruct the Owner's representative on the operation of the control system for a period of not less than two (2) eight (8) hour days**.** All training shall be by the control contractor and shall utilize specified manuals and as-built documentation.

E. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
3. Review data in maintenance manuals. Refer to Division 01 Section, *Contract Closeout.*
4. Review data in maintenance manuals. Refer to Division 01 Section, *Operation and Maintenance Data*.
5. Schedule training with Owner, through Architect, with at least seven days' advance notice.

1.14. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

1.15. DELAWARE TECHNICAL COMMUNITY COLLEGE SPECIFIC REQUIREMENTS

A. The ATC Subcontractor shall include in his bid all costs associated with incorporating the following specific requirements:

1. All holiday schedules shall incorporate a 12 month block. Coordinate exact holidays, schedules, calendars, occupied, unoccupied periods with Owner prior to writing software. All schedules shall be reviewed and approved by the Owner.
2. Relays for ATC equipments shall not be located in ceilings. All relays shall be located in equipment control panels and/or mechanical rooms.
3. All exhaust fans shall be assigned a designated point. Utilizing relays to provide digital point for exhaust fans shall not be acceptable.
4. Graphics on ATC computer shall in addition to basic requirements indicate the percentage open or closed on all valves and dampers.
5. The ATC Computer Graphics shall incorporate the final room numbers actually utilized in the school. All room names utilized in the graphic display shall be reviewed and approved by the Owner.
6. The ATC Computer Graphics shall indicate for each item of equipment the “on” or “off” status and command.
7. The ATC Computer Graphic shall indicate for each duct smoke detector the “on” or “off” status and command.
8. All Temperature Sensors, equipment, humidity sensors, current sensors, differential pressure sensors, etc indicated on ATC Control Diagrams and point list shall be displayed on the ATC Computer Graphic. Measured value or status shall be displayed.
9. For any multi-stage HVAC units, the quantity of compressor stages and the quantity of electric heat stages shall be displayed on the Computer Graphics.
10. The exact space temperature set points, humidity set points, changeover set points. etc., shall be coordinated with Owner prior to final data entry. All items indicated in sequences of Operation as “adjustable” shall be reviewed and approved by Owner prior to implementation of the same.
11. The outside air humidity, outside air temperature shall be monitored on ATC system and reported on ATC Computer Graphics. See Floor plans for exact locations.
12. Provide a graphic of all floor plans indicating location of all equipment interlocked with ATC System including all control panels. Graphic shall also indicate area of building served by equipment.

1.16. GLOBAL SENSORS

A. General

1. Furnish and install global sensors and report the same on the automatic temperature control system.
2. Global sensors shall monitor and trend the following conditions:

a). Outside air temperature.
b). Outside air humidity.
c). Geothermal supply water temperature.
d). Geothermal return water temperature.
e). All ventilation fan speeds where variable frequency drives are specified (ERV).
f). Outside air carbon dioxide level.
g). All ventilation fan amperage where variable frequency drives are specified.
h). All pump or fan speeds where variable frequency drives are specified.
i). All pump amperage's where variable frequency drives are specified.
j). All fan amperages where variable speed fans are indicated.

PART 2. PRODUCTS

2.1. BUILDING MANAGEMENT SYSTEM

A. The Building Management System (BMS) shall use an open architecture and fully support a multi-vendor environment. To accomplish this effectively, the BMS shall support open communication protocol standards and integrate a wide variety of third-party devices and applications. The system shall be designed for use on the Internet, or intranets using off the shelf, industry standard technology compatible with other owner provided networks.

B. The Building Management System shall consist of the following:

1. Standalone Network Automation Engine(s)
2. Field Equipment Controller(s)
3. Input/Output Module(s)
4. Local Display Device(s)
5. Portable Operator's Terminal(s)
6. Distributed User Interface(s)
7. Network processing, data storage and communications equipment
8. Other components required for a complete and working BMS

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, controllers and operator devices, while re-using existing controls equipment.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Acceptable Manufacturers

1. Johnson Controls, Pritchett Controls, Siemens, Honeywell, Automated Logic Cooperation, or Alerton.

F. Automation Network

1. The automation network shall be based on a PC industry standard of Ethernet TCP/IP. Where used, LAN controller cards shall be standard "off the shelf" products available through normal PC vendor channels.
2. The automation network shall be capable of operating at a communication speed of 100 Mbps, with full peer-to-peer network communication.
3. Network Automation Engines (NAE) shall reside on the automation network.
4. The automation network will be compatible with other enterprise-wide networks. Where indicated, the automation network shall be connected to the enterprise network and share resources with it by way of standard networking devices and practices.

G. Control Network

1. Network Automation Engines shall provide supervisory control over the control network and shall support all three (3) of the following communication protocols:

   a). BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9.
   b). LonWorks enabled devices using the Free Topology Transceiver (FTT-10a).
   c). The Johnson Controls N2 Field Bus or equivalent.
   d). Tridium FX-40
   e). Honeywell Webs

2. Control networks shall provide either "Peer-to-Peer," Master-Slave, or Supervised Token Passing communications, and shall operate at a minimum communication speed of 9600 baud.
3. DDC Controllers shall reside on the control network.
4. Control network communication protocol shall be BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135.
5. A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
6. The Conformance Statements shall be submitted 10 day prior to bidding.

H. Integration

1. Hardwired

   a). Analog and digital signal values shall be passed from one system to another via hardwired connections.
   b). There will be one separate physical point on each system for each point to be integrated between the systems.

2. BACnet Protocol Integration – BACnet

   a). The neutral protocol used between systems will be BACnet over Ethernet and comply with the ASHRAE BACnet standard 135-2003.
   b). A complete Protocol Implementation Conformance Statement (PICS) shall be provided for all BACnet system devices.
   c). The ability to command, share point object data, change of state (COS) data and schedules between the host and BACnet systems shall be provided.

I. Dedicated Web Based User Interface

1. Where required by the Owner, the BMS Contractor shall provide and install a personal computer for command entry, information management, network alarm management, and database management functions. All real-time control functions, including scheduling, history collection and alarming, shall be resident in the BMS Network Automation Engines to facilitate greater fault tolerance and reliability.
2. Dedicated User Interface Architecture – The architecture of the computer shall be implemented to conform to industry standards, so that it can accommodate applications provided by the BMS Contractor and by other third party applications suppliers, including but not limited to Microsoft Office Applications. Specifically it must be implemented to conform to the following interface standards.

   a). Microsoft Internet Explorer for user interface functions
   b). Microsoft Office Professional for creation, modification and maintenance of reports, sequences other necessary building management functions
   c). Microsoft Outlook or other e-mail program for supplemental alarm functionality and communication of system events, and reports
   d). Required network operating system for exchange of data and network functions such as printing of reports, trends and specific system summaries.

3. PC Hardware – The personal computer(s) shall be configured as follows:

   a). Memory – 1 GB (512 MB Minimum)
   b). CPU– Pentium 4 processor. 2.8 Hz Clock Speed (2.0 GHz minimum)
   c). Hard Drive – 80 GB free hard drive space (40GB minimum)
   d). Hard drive backup system – CD/RW, DVD/RW or network backup software provided by IT department
   e). CD ROM Drive – 32X performance
   f). Ports – (2) Serial and (1) parallel, (2) USB ports
   g). Keyboard – 101 Keyboard and 2 Button Mouse
   h). CRT configuration – 1-2 CRTs as follows:

      1). Each Display – 17" Flat Panel Monitor 1280 x 1024 resolution minimum.
      2). 16 bit or higher color resolution
      3). Display card with multiple monitor support

   i). LAN communications – Ethernet communications board; 3Comm or equal.

4. Operating System Software

   a). Windows 2010 Professional or Windows XP Professional
   b). Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
   c). Provide software registration cards to the Owner for all included software.

5. Peripheral Hardware

   a). Reports printer:

      1). Printer Make – Hewlett Packard DeskJet
      2). Print Speed – 600 DPI Black, 300 DPI Color
      3). Buffer – 64 K Input Print Buffer
      4). Color Printing – Include Color Kit

J. Distributed Web Based User Interface

1. All features and functions of the dedicated user interface previously defined in this document shall be available on any computer connected directly or via a wide area or virtual private network (WAN/VPN) to the automation network and conforming to the following specifications.
2. The software shall run on the Microsoft Internet Explorer (6.0 or higher) browser.
3. Minimum hardware requirements:

   a). 256 MB RAM
   b). 2.0 GHz Clock Speed Pentium 4 Microprocessor.
   c). 40.0 GB Hard Drive.
   d). 1 Keyboard with 83 keys (minimum).
   e). SVGA 1024x768 resolution display with 64K colors and 16 bit color depth.
   f). Mouse or other pointing device

K. User Interface Application Components

1. Operator Interface

   a). An integrated browser based client application shall be used as the user operator interface program.
   b). All Inputs, Outputs, Setpoints, and all other parameters as defined within Part 3 or Part 4, shown on the design drawings, or required as part of the system software, shall be displayed for operator viewing and modification from the operator interface software.
   c). The user interface software shall provide help menus and instructions for each operation and/or application.
   d). All controller software operating parameters shall be displayed for the operator to view/modify from the user interface. These include: setpoints,

alarm limits, time delays, PID tuning constants, run-times, point statistics, schedules, and so forth.

e). The Operator Interface shall incorporate comprehensive support for functions including, but not necessarily limited to, the following:

1). User access for selective information retrieval and control command execution
2). Monitoring and reporting
3). Alarm, non-normal, and return to normal condition annunciation
4). Selective operator override and other control actions
5). Information archiving, manipulation, formatting, display and reporting
6). FMS internal performance supervision and diagnostics
7). On-line access to user HELP menus
8). On-line access to current FMS as-built records and documentation
9). Means for the controlled re-programming, re-configuration of FMS operation and for the manipulation of FMS database information in compliance with the prevailing codes, approvals and regulations for individual FMS applications.
10). The operation of the control system shall be independent of the user interface, which shall be used for operator communications only. Systems that rely on an operator workstation to provide supervisory control over controller execution of the sequences of operations or system communications shall not be acceptable.

2. Navigation Trees

a). The system will have the capability to display multiple navigation trees that will aid the operator in navigating throughout all systems and points connected. At minimum provide a tree that identifies all systems on the networks.

b). Provide the ability for the operator to add custom trees. The operator will be able to define any logical grouping of systems or points and arrange them on the tree in any order. It shall be possible to nest groups within other groups. Provide at minimum 5 levels of nesting.

c). The navigation trees shall be “dockable” to other displays in the user interface such as graphics. This means that the trees will appear as part of the display, but can be detached and then minimized to the Windows task bar or closed altogether. A simple keystroke will reattach the navigation to the primary display of the user interface.

3. Alarms

a). Alarms shall be routed directly from Network Automation Engines to PCs and servers. It shall be possible for specific alarms from specific points to be routed to specific PCs and servers. The alarm management portion of the user interface shall, at the minimum, provide the following functions:

1). Log date and time of alarm occurrence.

2). Generate a "Pop-Up" window, with audible alarm, informing a user that an alarm has been received.
3). Allow a user, with the appropriate security level, to acknowledge, temporarily silence, or discard an alarm.
4). Provide an audit trail on hard drive for alarms by recording user acknowledgment, deletion, or disabling of an alarm. The audit trail shall include the name of the user, the alarm, the action taken on the alarm, and a time/date stamp.
5). Provide the ability to direct alarms to an e-mail address or alphanumeric pager. This must be provided in addition to the pop up window described above. Systems that use e-mail and pagers as the exclusive means of annunciating alarms are not acceptable.
6). Any attribute of any object in the system may be designated to report an alarm.

b). The FMS shall annunciate diagnostic alarms indicating system failures and non-normal operating conditions
c). The FMS shall annunciate application alarms as required.

4. Reports and Summaries

a). Reports and Summaries shall be generated and directed to the user interface displays, with subsequent assignment to printers, or disk. As a minimum, the system shall provide the following reports:

1). All points in the BMS
2). All points in each BMS application
3). All points in a specific controller
4). All points in a user-defined group of points
5). All points currently in alarm
6). All points locked out
7). All BMS schedules
8). All user defined and adjustable variables, schedules, interlocks and the like.

b). Summaries and Reports shall be accessible via standard UI functions and not dependent upon custom programming or user defined HTML pages.
c). Selection of a single menu item, tool bar item, or tool bar button shall print any displayed report or summary on the system printer for use as a building management and diagnostics tool.
d). The system shall allow for the creation of custom reports and queries via a standard web services XML interface and commercial off-the-shelf software such as Microsoft Access, Microsoft Excel, or Crystal Reports.

5. Schedules

a). A graphical display for time-of-day scheduling and override scheduling of building operations shall be provided. At a minimum, the following functions shall be provided:

1). Weekly schedules
2). Exception Schedules
3). Monthly calendars

b). Weekly schedules shall be provided for each group of equipment with a specific time use schedule.
c). It shall be possible to define one or more exception schedules for each schedule including references to calendars
d). Monthly calendars shall be provided that allow for simplified scheduling of holidays and special days for a minimum of five years in advance. Holidays and special days shall be user-selected with the pointing device or keyboard, and shall automatically reschedule equipment operation as previously defined on the exception schedules.
e). Changes to schedules made from the User Interface shall directly modify the Network Automation Engine schedule database.
f). Schedules and Calendars shall comply with ASHRAE SP135/2003 BACnet Standard.
g). Selection of a single menu item or tool bar button shall print any displayed schedule on the system printer for use as a building management and diagnostics tool.

6. Password

a). Multiple-level password access protection shall be provided to allow the user/manager to user interface control, display, and database manipulation capabilities deemed appropriate for each user, based on an assigned password.
b). Each user shall have the following: a user name (24 characters minimum), a password (12 characters minimum), and access levels.
c). The system shall allow each user to change his or her password at will.
d). When entering or editing passwords, the system shall not echo the actual characters for display on the monitor.
e). A minimum of five levels of access shall be supported individually or in any combination as follows:

1). Level 1 = View Data
2). Level 2 = Command
3). Level 3 = Operator Overrides
4). Level 4 = Database Modification
5). Level 5 = Database Configuration
6). Level 6 = All privileges, including Password Add/Modify

f). A minimum of 100 unique passwords shall be supported.
g). Operators shall be able to perform only those commands available for their respective passwords. Display of menu selections shall be limited to only those items defined for the access level of the password used to log-on.
h). The system shall automatically generate a report of log-on/log-off and system activity for each user. Any action that results in a change in the

operation or configuration of the control system shall be recorded, including: modification of point values, schedules or history collection parameters, and all changes to the alarm management system, including the acknowledgment and deletion of alarms.

7. Screen Manager - The User Interface shall be provided with screen management capabilities that allow the user to activate, close, and simultaneously manipulate a minimum of 4 active display windows plus a network or user defined navigation tree.

8. Dynamic Color Graphics

   a). The graphics application program shall be supplied as an integral part of the User Interface. Browser or Workstation applications that rely only upon HTML pages shall not be acceptable.

   b). The graphics applications shall include a create/edit function and a runtime function. The system architecture shall support an unlimited number of graphics documents (graphic definition files) to be generated and executed.

   c). The graphics shall be able to display and provide animation based on real-time data that is acquired, derived, or entered.

   d). Graphics runtime functions – A maximum of 16 graphic applications shall be able to execute at any one time on a user interface or workstation with 4 visible to the user. Each graphic application shall be capable of the following functions:

      1). All graphics shall be fully scalable
      2). The graphics shall support a maintained aspect ratio.
      3). Multiple fonts shall be supported.
      4). Unique background shall be assignable on a per graphic basis.
      5). The color of all animations and values on displays shall indicate if the status of the object attribute.

   e). Operation from graphics – It shall be possible to change values (setpoints) and states in system controlled equipment by using drop-down windows accessible via the pointing device

   f). Graphic editing tool – A graphic editing tool shall be provided that allows for the creation and editing of graphic files. The graphic editor shall be capable of performing/defining all animations, and defining all runtime binding.

      1). The graphic editing tool shall in general provide for the creation and positioning of point objects by dragging from tool bars or drop-downs and positioning where required.
      2). In addition, the graphic editing tool shall be able to add additional content to any graphic by importing backgrounds in the SVG, BMP or JPG file formats.

   g). Aliasing – Many graphic displays representing part of a building and various building components are exact duplicates, with the exception that

the various variables are bound to different field values. Consequently, it shall be possible to bind the value of a graphic display to aliases, as opposed to the physical field tags.

9. Historical trending and data collection

a). Each Automation Engine shall store trend and point history data for all analog and digital inputs and outputs, as follows:

1). Any point, physical or calculated, may be designated for trending. Three methods of collection shall be allowed:

i Defined time interval
ii Upon a change of value.

2). Each Automation Engine shall have the capability to store multiple samples for each physical point and software variable based upon available memory, including an individual sample time/date stamp. Points may be assigned to multiple history trends with different collection parameters.

b). Trend and change of value data shall be stored within the engine and uploaded to a dedicated trend database or exported in a selectable data format via a provided data export utility. Uploads to a dedicated database shall occur based upon one of the following: user-defined interval, manual command, or when the trend buffers are full. Exports shall be as requested by the user or on a time scheduled basis.

10. Trend data viewing and analysis

a). Provide a trend viewing utility that shall have access to all database points.
b). It shall be possible to retrieve any historical database point for use in displays and reports by specifying the point name and associated trend name.
c). The trend viewing utility shall have the capability to define trend study displays to include multiple trends
d). Displays shall be able to be single or stacked graphs with on-line selectable display characteristics, such as ranging, color, and plot style.
e). Display magnitude and units shall both be selectable by the operator at any time without reconfiguring the processing or collection of data. This is a zoom capability.
f). Display magnitude shall automatically be scaled to show full graphic resolution of the data being displayed.
g). Trend studies shall be capable of calculating and displaying calculated variables including highest value, lowest value and time based accumulation.

L. Portable Operator Terminal

1. For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:

    a). Personal Laptop Computer Manufacturer – Dell, Compaq or HP
    b). 1 GB RAM (256 MB minimum) – Windows 2000 or XP Professional.
    c). 1.8 GHz Clock Speed Pentium 4 Microprocessor (800 MHz minimum).
    d). 40 GB Hard Drive. (40 GB minimum)
    e). (1) CD-ROM Drive, 32x speed.
    f). (1) Serial (1) Parallel (2) USB ports
    g). 1 Keyboard with 83 keys (minimum).
    h). Integral 2 button Track Point or Track Ball.
    i). 10" SVGA 1024x768 resolution color display
    j). Two PCMCIA Type II or one Type III card slot.
    k). Complete operator workstation software package, including any hardware or software.
    l). Original printed manuals for all software and peripherals.
    m). Original installation disks or CD for all software, device drivers, and peripherals.
    n). Software registration cards for all included software shall be provided to the Owner.
    o). Carrying case.
    p). Spare battery.
    q). External power supply/battery charger.

2. Proprietary Portable Terminal

    a). Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.
    b). The proprietary terminal shall meet the same operator interface software requirements as specified above.

3. Software

    a). Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.
    b). When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.
    c). When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

M. Network Automation Engine (NAE)

1. The Network Automation Engine (NAE) shall be a fully user-programmable, supervisory controller. The NAE shall monitor the network of distributed

application-specific controllers, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Automation Engines.

2. Automation network – The NAE shall reside on the automation network and shall support a subnet of system controllers.
3. User Interface – Each NAE shall have the ability to deliver a web based User Interface (UI) as previously described. All computers connected physically or virtually to the automation network shall have access to the web based UI.

    a). The web based UI software shall be imbedded in the NAE. Systems that require a local copy of the system database on the user's personal computer are not acceptable.
    b). The NAE shall support up four (4) concurrent users.
    c). The web based user shall have the capability to access all system data through one NAE.
    d). Remote users connected to the network through an Internet Service Provider (ISP) or telephone dial up shall also have total system access through one NAE.
    e). Systems that require the user to address more than one NAE to access all system information are not acceptable.
    f). The NAE shall have the capability of generating web based UI graphics. The graphics capability shall be imbedded in the NAE.
    g). Systems that support UI Graphics from a central database or require the graphics to reside on the user's personal computer are not acceptable.
    h). The web based UI shall support the following functions using a standard version of Microsoft Internet Explorer:
        1). Configuration
        2). Commissioning
        3). Data Archiving
        4). Monitoring
        5). Commanding
        6). System Diagnostics
    i). Systems that require workstation software or modified web browsers are not acceptable.
    j). The NAE shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems.

4. Processor – The NAE shall be microprocessor-based with a minimum word size of 32 bits. The NAE shall be a multi-tasking, multi-user, and real-time digital control processor. Standard operating systems shall be employed. NAE size and capability shall be sufficient to fully meet the requirements of this Specification.
5. Memory – Each NAE shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control level devices.
6. Hardware Real Time Clock – The NAE shall include an integrated, hardware-based, real-time clock.
7. The NAE shall include troubleshooting LED indicators to identify the following conditions:

    a). Power - On/Off

b). Ethernet Traffic – Ethernet Traffic/No Ethernet Traffic
c). Ethernet Connection Speed – 10 Mbps/100 Mbps
d). FC Bus – Normal Communications/No Field Communications
e). Peer Communication – Data Traffic Between NAE Devices
f). Run – NAE Running/NAE In Startup/NAE Shutting Down/Software Not Running
g). Bat Fault – Battery Defective, Data Protection Battery Not Installed
h). Fault – General Fault
i). Modem RX – NAE Modem Receiving Data
j). Modem TX – NAE Modem Transmitting Data

8. Communications Ports – The NAE shall provide the following ports for operation of operator Input/Output (I/O) devices, such as industry-standard computers, modems, and portable operator's terminals.

a). Up to two (2) USB port
b). Up to two (2) URS-232 serial data communication port
c). Up to two (2) RS-485 port
d). One (1) Ethernet port

9. Diagnostics – The NAE shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The Network Automation Engine shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
10. Power Failure – In the event of the loss of normal power, The NAE shall continue to operate for a user adjustable period of up to 10 minutes after which there shall be an orderly shutdown of all programs to prevent the loss of database or operating system software.

a). During a loss of normal power, the control sequences shall go to the normal system shutdown conditions. All critical configuration data shall be saved into Flash memory.
b). Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.

11. Certification – The NAE shall be listed by Underwriters Laboratories (UL).
12. Controller network – The NAE shall support the following communication protocols on the controller network:

a). The NAE shall support BACnet Standard MS/TP Bus Protocol ASHRAE SSPC-135, Clause 9 on the controller network.

1). A BACnet Protocol Implementation Conformance Statement shall be provided for each controller device (master or slave) that will communicate on the BACnet MS/TP Bus.
2). The Conformance Statements shall be submitted 10 day prior to bidding.

3). The NAE shall support a minimum of 100 control devices.

b). The NAE shall support the Johnson Controls N2, Tridium FX-40, or Honeywell Webs or approved equal Field Bus.
1). The NAE shall support a minimum of 100 N2 control devices.
2). The Bus shall conform to Electronic Industry Alliance (EIA) Standard RS-485.
3). The Bus shall employ a master/slave protocol where the NAE is the master.
4). The Bus shall employ a four (4) level priority system for polling frequency.
5). The Bus shall be optically isolated from the NAE.
6). The Bus shall support the Metasys Integrator System.

2.2. WIRING

A. The multi-conductor cable for field wiring of electronic analog sensors shall be minimum No. 22 AWG, 300 volt, thermoplastic with stranded copper wire and 100 percent shield coverage. The number of conductors in each sensor cable shall be as determined by the Contractor. 2/c #22 shielded cables shall be Belden Cat. #8451 3/c #20 shielded cables shall be Belden Cat. #9770.

B. Conductors for digital sensors or contact control shall be the same as for the analog sensors, except the grounded shield is not required.

C. Individual conductors shall be color coded and in addition shall be numbered in the field to identify the particular terminal to which attached. Field numbering shall be performed with Brady markers wrapped around the wire near the terminal connection. All wires shall be terminated with pressure type connectors suitable for wire size, material and terminal connection.

D. All exposed wiring shall be installed in a designated conduit raceway. The conduit shall conform to Division 26 of the specification. Concealed wiring shall be plenum rated cable.

E. All junction boxes shall have covers painted *safety green*, and be rigid steel.

F. All wiring between differential pressure transmitters and variable frequency drive pump controllers shall be shielded and grounded at the pump controller end. Directly route the variable frequency drive pump controller to the differential pressure transmitter(s).

2.3. CONTROLLERS

A. Temperature sensor covers shall be stainless steel wire guard type with vandal proof screws. All room temperature sensors shall be mounted 5'-3 inches above the finished floor, except in stairways, corridors and toilets, which shall be 7'-0 inches. Provide insulating bases where temperature sensors are located on exterior or unconditioned walls. Each temperature sensor shall have adjustable limit stops and adjustable sensitivity. Room temperature sensors shall

be Network 8000, TS-90250-850 or approved equal with 55 degrees F to 85 degrees F set point adjustment. Temperature sensors shall include set-point adjustors, U.L. approved for mounting base in air plenums, and RJ-11 jack for communications.

2.4. DAMPERS

A. Control Dampers

1. The temperature control contractor shall provide all automatic control dampers of the types indicated on the plans and not specified to be integral with other equipment. Frames shall be not less than 16 gauge galvanized steel. Blades shall not be over 6 inches wide airfoil shaped double skin construction of 14 gauge equivalent thickness. Bearings shall be stainless steel sleeves with 2 inch shafts. Blade edge seals shall be vinyl blade with flexible metal compressible jamb seals of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 250 degrees F.
2. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade type.
3. Dampers shall be sized to meet flow requirements of the application. The sheet metal contractor shall furnish and install baffles to fit the damper to duct size. Baffles shall not exceed 6 inches.
4. Dampers shall be minimum leakage type to conserve energy and the temperature control manufacturer shall submit leakage and flow characteristic data for all control dampers with the temperature control submittal. Maximum leakage shall be 3 CFM/Sq. Ft. at static pressure of 1 inch W.C. for a damper width of 48 inches.
5. Ultra-low leakage dampers shall have blade edges shall to be fitted with replaceable, snap-on, inflatable seals to limit damper leakage to 2 percent at applied static pressure.
6. Low pressure rectangular control dampers shall be Type CD60 airfoil low leakage damper as manufactured by Ruskin or as approved equal of American Warming and Ventilating, Air Balance and Arrow.
7. Round control dampers shall be Type CERS25 with blade edge seals as manufactured by Ruskin or as approved equal.

B. Smoke Detectors

1. Smoke detectors shall be provided by the Electrical Contractor and installed by the Mechanical Contractor. All wiring, interlocks, etc., to be provided by Electrical Contractor. Wiring from duct smoke detectors to fans shall be by ATC Contractor. Duct smoke detectors shall be tested by the Test and Balance Engineer as specified in Division 23 Section, *Testing, Adjusting & Balancing for HVAC and Plumbing.*

C. Damper Operators

1. Electric damper actuators shall be properly sized to provide sufficient torque to position the damper throughout its operating range.
2. Use devices which are quiet in operation and which in the event of power failure, will "fail safe" by spring action in either the normally open or normally closed

position as required for freeze, moisture, smoke, or fire protection.

3. Electric actuators requiring a 24 VAC power supply will be utilized. Motors shall be specifically designed and sized with proper torque according to requirements of the device it is to be used on (i.e.: valve, damper). Each actuator will accept the proper control input as the system is designed, (i.e,: floating, 0-10VDC, 4-20Ma etc.) without the need for any additional interface devices.

2.5. HYDRONIC CONTROL VALVES

A. All automatic control valves 2 inches and smaller shall be screwed type, and valves 2 ½ inches and larger shall be flanged. Valves shall be factory-rated to withstand the pressures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable seats and discs. All control valves must be capable of withstanding the shut-off head of the pump, they are connected to without the valve seat lifting. Valves shall have stainless steel stems and spring loaded Teflon packing with replaceable seats and discs.

1. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. All three-way valves shall be provided with linear throttling plugs such that the total flow through the valve shall remain constant regardless of the valve's position modulating. Valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and discs.
2. Where applicable, all two (2) position control valves may be furnished with hose kits at Contractor's option. Coordinate actuator and pressure drop requirements with hose kit supplier. Maximum allowable pressure drop for two (2) position control valves shall be 3 feet at scheduled flow rate.
3. Optional accessories shall include a stem packing lubricator for factory or field assembly. Valve stem packing shall be low friction, tight sealing Teflon.
4. Unitary valves shall be straight-through or three way type as specified in the sequence of operation with high-pressure connections suitable for copper pipe and rated for 250 psig. Stems shall be polished stainless-steel and packing shall be ethylene-propylene suitable for both chilled water and 250 degree hot water service. Straight-through valves shall have back-seating feature, to allow packing to be replaced without draining system.
5. All valves shall use guided valve plugs for good seating and reliable operation. Valves ½ inch to 1 inch shall be ANSI Class 125 brass body with screwed ends. Valves 1-1/4 inches to 2 inches shall be ANSI Class 150 brass body with screwed ends. Valves 2-1/2 inches to 4 inches shall be Class 125 cast iron body with bronze trim and flanged ends. Valves 6 inches and larger shall be Class 125 steel body with bronze trim and flanged ends. Butterfly valves shall be DeZurick HIGH performance or Keystone Keylock, Lug style as specified in Division 23 Section, *HVAC Piping, Fittings, and Valves*.
6. All dual temperature valves shall be normally open to the coil.

B. Control Valve Operators

1. Electric valve actuators shall be properly sized to provide sufficient torque to position valves throughout its operating range.

2. Use devices which are quiet in operation and which in the event of power failure, will "fail safe" by spring action in either the normally open or normally closed position as required for freeze, moisture, smoke, or fire protection. Spring return valves are required for all control valves where coils are exposed to outside air conditions.
3. Electric actuators requiring a 24VAC power supply will be utilized. Motors shall be specifically designed and sized with proper torque according to requirements of the device it is to be used on (i.e: valve, damper). Each actuator will accept the proper control input as the system is designed, (i.e.: floating, 0-10VDC, 4-10Ma etc.) without the need for any additional interface devices.

2.6. CONTROL PANELS

A. Furnish and install local panels for ATC devices. Control panels shall be fully enclosed cabinets, all steel construction and shall meet the requirements of NEMA 1 enclosures. Cabinet shall have piano hinged door with a locking latch. All cabinet locks shall use common key. Provide means of storing control system instructions and drawings inside cabinet for future reference. Panel shall be wall mounted or free standing and located where directed by the Contract Drawings or Engineer.

1. Each panel shall have all internal devices factory wired to a numbered terminal strip. Controllers and associated devices shall be mounted within the panel, accessible through a hinged door.
2. All ATC panels shall be provided with integral disconnect, wiring, and control transformers.

2.7. MISCELLANEOUS ELECTRICAL DEVICES

A. Electric Actuators. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electric actuators which shall be sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close off as specified.

B. Aquastats shall be line voltage strap on type with single pole, single throw switching. Switches shall have an adequate rating for the applied load. All wiring from aquastats to domestic recirculating pumps shall be by ATC contractor.

2.8. CENTRAL CONTROL AND MONITORING SYSTEM (CCMS) (HARDWARE DESCRIPTION)

A. General

1. The Facilities Management Control System (FMCS) shall be comprised of a network of various independent, Stand-alone Digital Controllers (SDC'S), Mechanical System Digital Controllers (MSDC's), Air Handler Digital Controllers (AHDC's), Unitary Digital Controllers (UDC's); together with Centralized Control Stations (CCS), and Centralized Host Stations (CHS) as specified, to provide

centralized access and facility wide control functions. The SDC's, MSDC's, AHDC's, or UDC's shall be interconnected in a communicating network to provide facility wide access and sharing of information. A Gateway Digital Controller (GDC's) shall be provided to allow interface with third party microprocessor based control systems that are specified for integration within specification. A Local Area Network (LAN) shall be provided to interconnect SDC's for high-speed data transmission.

2. Specification Nomenclature

FMCS	Facility Management Control System
SDC	Stand-alone Digital Controller
MSDC	Mechanical System Digital Controller
AHDC	Air Handler Digital Controller
UDC	Unitary Digital Controller
HHOT	Hand Held Operator Terminal
GDC	Gateway Digital Controller
GP	Graphical Programmer
CHS	Central Host Station
CCS	Central Control Station
RPTR	Communications Repeater

B. Centralized Host Stations (CHS)

1. The FMCS shall include Centralized Host Stations. CHS's shall, in conjunction with the full compliment of Digital Controllers, provide the performance requirements within this specification. Each CHS shall include all hardware and software components to serve as a centralized facility operator station, providing color graphics, facility wide access, operator initiation of global control strategies, and centralized documentation.

The CHS shall be capable of simultaneously interfacing with the following:

-mouse pointing device
-two parallel printers
-high resolution VGA color graphics monitor
-seven auto answer/auto dial modems
-color inkjet printer
-two serial printers
-three FMCS LAN interface
-Alarm Graphic and Report FAX dial out service interface
-Mass storage tape system

As a minimum, the temperature control contractor shall provide the types and quantities of CHS, CCS, SDC, MSDC, AHDC, GDC, and UDC as required.

2. Computer

a). The existing FMS computer located in the Maintenance Office shall be utilized with the new CCMS System if compatible with the same. If the

selected ATC contractor cannot tie into the existing computer, then a new stand-alone computer shall be furnished.

b). Coordinate IP address with Owners' I.T. Department for network connection. The CCMS must be fully networkable.

c). Provide fiber optic cable as required.

3. Operator Workstation: One PC-based microcomputer with minimum configuration as follows:

a). Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

b). Processor: Intel Pentium 4, 733 MHz.

c). Random-Access Memory: 2GB.

d). Graphics: Video adapter, minimum 1600 x 1200 pixels, 64-MB video memory, with TV out.

e). Monitor: 19 inches (480 mm)**,** LCD color.

f). Keyboard: QWERTY, 105 keys in ergonomic shape.

g). Floppy-Disk Drive: 1.44 MB.

h). Hard-Disk Drive: 80 GB.

i). CD-ROM Read/Write Drive: 48x24x48.

j). Mouse: Three button, optical.

k). Uninterruptible Power Supply: 2 kVa.

l). Operating System: Microsoft Windows XP Professional with high-speed Internet access.

1). ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

2). LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

m). Printer: Color, ink-jet type as follows:

1). Print Head: 4800 x 1200 dpi optimized color resolution.

2). Paper Handling: Minimum of 100 sheets.

3). Print Speed: Minimum of 17 ppm in black and 12 ppm in color.

n). Application Software:

1). I/O capability from operator station.

2). System security for each operator via software password and access levels.

3). Automatic system diagnostics; monitor system and report failures.

4). Database creation and support.

5). Automatic and manual database save and restore.

6). Dynamic color graphic displays with up to 10 screen displays at once.

7). Custom graphics generation and graphics library of HVAC

equipment and symbols.

8). Alarm processing, messages, and reactions.
9). Trend logs retrievable in spreadsheets and database programs.
10). Alarm and event processing.
11). Object and property status and control.
12). Automatic restart of field equipment on restoration of power.
13). Data collection, reports, and logs. Include standard reports for the following:

i Current values of all objects.
ii Current alarm summary.
iii Disabled objects.
iv Alarm lockout objects.
v Logs.

14). Custom report development.
15). Utility and weather reports.
16). Workstation application editors for controllers and schedules.
17). Maintenance management.

o). Custom Application Software:

1). English language oriented.
2). Full-screen character editor/programming environment.
3). Allow development of independently executing program modules with debugging/simulation capability.
4). Support conditional statements.
5). Support floating-point arithmetic with mathematic functions.
6). Contains predefined time variables.

p). P.C. shall be the latest technology at the time of installation of the front end.

C. Centralized Control Stations (CCS)

The FMCS shall include Centralized Control Stations, as required. CCS's shall, in conjunction with the network of SDC's and additional CCS components as required, provide the performance requirements within this section of the specification. Each CCS shall include all hardware and software components to serve as a centralized facility operator station, providing facility wide access, for review and modification of global control strategies, real time system monitoring, controller database editing or creation, and centralized documentation.

D. Local Area Networks

1. The LAN shall utilize packetized transmissions, CRC 16 error checking, and distributed error recovery. Single or multiple SDC failures shall not cause loss of communication between other LAN-connected SDC's.
2. LAN connected SDC's shall be provided with a communications watchdog to assure that an individual SDC cannot permanently occupy the LAN. If an SDC is

determined to be monopolizing communications, it shall be automatically shut down and an exception reported to annunciate this fact.

3. The LAN shall employ a token passing, peer-to-peer convention, same as or similar to the industry standard format IEEE 802.4. The content of messages shall be the manufacturer's standard. The Local Area Network components shall be manufacturer's standard or available from third party vendors which utilize the same chip implementation as used by the manufacturer.
4. Industry standard ANSI, RS-485 Network Communication System, Lon, or Bacnet, or Equivalent shall be utilized.

a). Trunk Wiring Practices - General

The distributed communication network system shall consist of a multi-drop RS-485 bus architecture connecting SDC's, MSDC's, AHDC's, GDC's, and UDC's. The trunk shall consist of:

1). A twisted pair of wires (24 awg) completely encased in continuous metallic conduit.
2). A twisted shielded pair of wires (24awg) with the shield grounded in accordance with the manufacturer's wiring practices.
3). Or a dual channel, 62.5 micron fiber cabling system with ST type connectors.

There shall be no power wiring, in excess of 30 VAC rms voltage, run in conduit with communications trunk wiring. In cases where power or signal wiring is run in conduit with trunk wiring, all communications trunk wiring and power wiring shall be run using separate twisted shielded pairs (24awg) with the shields grounded in accordance with the manufacturer's wiring practices.

b). Communication Transient Protection

1). The manufacturer's catalog data sheet shall provide evidence that all FMCS products offered by the manufacturer are tested and comply with the standard for Transient Surge withstand capabilities for electrical devices ANSI C62.41, IEEE-587-1980, Categories A and B. Such testing shall have included power and communication trunk wiring. Compliance with IEEE-587 shall imply conformance with IEEE-472 transient standards based on the stated position of ANSI and IEEE regarding applicability of the rated standards.
2). In addition, at each building entry and exit point, the wire communications trunk wiring shall be protected with a transient surge protection device providing the minimal protection specifications of the General semiconductor, Model #422E device. Transient surge protection is not necessary if the communication trunk, external to the building, is fiber optic in nature.

3). The communications circuitry and input/output circuitry, of the SDC's, MSDC's, or AHDC's shall provide protection against a 1000 volt, 3 amp transient signal, directly applied to the communication or input/output terminations. The manufacturer's catalog data sheet shall provide evidence of conformance with this requirement. Systems not complying with this requirement shall provide equivalent protection external to the FMCS controller. Protection shall be provided for the individual communications and input/output terminations for each FMCS controller. Submittal documentation shall clearly define how this requirement will be met and how the external protection will not affect the performance of the controllers.

c). RS-485 Trunk Distance and Topology

The manufacturer's RS-485 trunk shall provide operation over end to end linear distances of 4000 feet for wire connections and 6,500 feet for fiber optic connections, without repeaters, at communication data rates of up to 64 kbps. The trunk may be extended up to 20,000 feet through the use of wire repeaters or 80,000 feet through the use of fiber optic repeaters.

At data rates of up to 19.2 kbps, the trunk distance shall be extendible to distances of up to 20,000 feet using RS-485 communication wire or fiber optic repeaters. A repeater shall be used each 4,000 feet of linear distance for wire or every 6,500 feet for fiber optics. Repeating devices shall contain separate LED indication for each communication interface trunk to indicate proper operation of the repeater as well as the communications trunks.

Contractors shall provide devices which are of FMCS control system manufacturer's design.

It shall be possible for the trunk to be "T" eed or "starred", at any location using a repeater, to facilitate the installation. Systems which do not provide this capability shall provide a trunk riser diagram showing end to end distances and locations of system topology necessary to meet the trunk diagram shown on the plans.

d). Fiber Optic Communication Trunk

The temperature control contractor shall provide a dual channel fiber optic data link, as required, to minimize the effects of transient surges caused by lightning or external EMI generating equipment. The data link shall be comprised of a single duplex cable containing two fibers (transmit and receive), of 62.5 micron construction, to accommodate data rates of up to 64 kbps.

The fiber optic trunk shall be connected to SDC devices using manufacturer's standard RS-485 to fiber optic data link modem. Repeating devices shall contain separate LED indication for each communication

interface and the fiber modem, to indicate proper operation of all aspects of the device. Fiber modem devices shall be tested and conform with transient surge withstand tests for electrical devices, ANSI C62.41 IEEE-587 Categories A and B. Manufacturer's data sheet shall provide evidence of compliance with this requirement. Manufacturer's products which do not meet this minimum performance requirement shall not be acceptable.

Systems which require a special gateway controller to accommodate the fiber optic trunks, shall provide such a controller per point where the fiber optic cable enters and leaves the building. Gateway controllers shall not inhibit transfer of point data values between SDC controllers throughout the LAN. Such inhibitive systems shall not be acceptable.

In lieu of the above two options, the contractor may provide a fiber optic link to each SDC controller within the LAN. All controllers shall have access to the fiber optic link for LAN.

Fiber optic cable shall be fully tested and terminated by the temperature control contractor.

E. Standalone Digital Controllers (SDC)

1. General

Standalone Digital Controllers (SDC) shall be 16 bit microcomputer based, utilizing a multi-tasking, multi-user operating system.

The SDC controllers shall permit the simultaneous operation of all control, communication facilities management and operator interface software, as programmed by the Contractor or User. Modification of the on-board SDC controller database shall be performed on-line using the built-in or HHOT interface. Systems which require the SDC to be removed from service while DDC control sequences are modified shall not be acceptable.

SDC controllers shall utilize true floating point arithmetic capabilities. To accommodate totalization of large totalized values, SDC's with reporting capability shall support the calculation, accumulation and display of values within the range of +/-10 to the 10th power.

2. Database and Memory Back-up

All programming defining the functions to be performed by the SDC, including but not limited to application programs and point database within each SDC, shall be protected from loss due to power failure for a minimum of six months. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6 month period. Systems not in compliance shall provide for uninterrupted power to each SDC.

3. Service Ports

SDC controllers shall be equipped with a minimum of one operator service port for the connection of a HHOT. The service port shall be either a built-in RS-232 data terminal port or an RJ-11 type jack which connects to the manufacturer's standard HHOT.

Connection of a service device, to a service port, shall not cause the SDC controller to lose communications with its peers or other networked device controllers.

The service port shall allow utilization of the same HHOT from any location. The same HHOT shall be utilized for any SDC, MSDC, AHDC, or UDC, Systems which utilize more than one variety of HHOT shall not be acceptable.

4. Display and Readout Capability

The SDC controller shall provide manufacturer’s standard display and readout capability.

5. Manual/Auto Control and Notification

The SDC controller shall provide commanded override capability from the HHOT or the built-in operator interface. Such overrides shall be annunciated to the CHS's. Such overrides shall be valid as long as power is applied to the controller.

Manual service overrides, such as Hand/Off/Auto switches, shall be provided as indicated on the drawings. Such overrides shall be located at the controlled device location and conform with OSHA Manual lockout regulations, as appropriate, for safety reasons. SDC indication of such manual override actions shall be provided as feedback status indication points shown on the drawings, in conjunction with the application programs within the SDC. Systems which provide built-in H/O/A switching devices with integral feedback shall provide external manual service overrides, as indicated, to comply with OSHA manual lockout regulations. H/O/A switches remotely located at the SDC controller are not acceptable.

6. Adjustments

Every control panel shall provide adjustments for the functions specified. In general, adjustments shall be provided for all set points used by controllers within each control panel. In addition, adjustments shall be provided for throttling ranges, mixed air damper minimum positions, or other items as specified. Adjustments shall be integral to each individual SDC. The built-in operator interfaces shall allow the easy execution of the adjustment through named identifiers within the SDC. From a single SDC user interface, any other SDC shall be accessible and full adjustment capabilities shall be provided.

7. Sensing and Control Outputs Requirements

a). Sensing

All sensing inputs shall be provided via industry standard signals. Temperatures, humidities, differential pressure signals, and other signal inputs shall be one of the following types:

0-20 mA

4-20 mA
0-5 VDC
0-12 VDC
1000 ohm platinum (at O{SYMBOL 176\f"Symbol"}C,2.62 ohms/C)
1000 ohm Balco (2.2 ohms/{SYMBOL 176\f"Symbol"}F)
10 k ohm Thermistor (at 25{SYMBOL 176\f"Symbol"}C/77{SYMBOL 176\f "SYMBOL"}F)

Custom, definable input signals (accept sensor inputs from RTD devices, other than those of the manufacturer).

All signal inputs shall be compatible with the controllers used, and with the requirements for readout of variables in true scaled engineering units as specified.

b). Control Outputs

1). On/Off Outputs

Control panel shall internally provide test points for the circuit driving the equipment contactor, for the purpose of troubleshooting the 120 VAC or 240 VAC circuit to the contactor. All such relays or digital output modules shall provide a pilot light or LED display of the same status. On/Off output modules shall be of the modular construction that can be easily and quickly replaced, on an individual basis, if the module were to be damaged.

2). Modulating Outputs

Modulating outputs shall be industry standard 0-5 VDC, or 0-12 VDC with definable output spans, to adapt to industry available control products. Milliamp outputs of 0-20 mA or 4-20 mA are also acceptable. Drive open/Drive closed type modulating outputs are acceptable provided that they also comply with the following requirements.

All modulating outputs shall provide within the control panel, a meter gauge, or display indication via on board display or HHOT, the commanded position signal for the actuating device. This meter, gauge, or display must provide either a 0-100 percent position indication, or read out directly in the engineering unit of the signal being used. Drive open/Drive closed type controllers shall include sufficient components and control algorithms to comply with this requirement. In the case of Drive open/closed technology, position feedback shall be provided to insure positive indication that the control device is at the commanded position.

F. Mechanical System Digital Controllers (Msdc's)

1. General

a). Controls shall be microprocessor based, Mechanical System Direct Digital

Controllers (MSDC's). MSDC's shall be provided for air handling units, central pump systems and other applications as required. MSDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the MSDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates sensor signals. All input/output signal conversion shall be performed through a minimum of a 12 Bit A to D converter. All input/output points shall be universal in nature allowing their individual function definition to be assigned through the application software. All unused input/output points must be available as universally definable at the owner discretion. If input/output points are not fully universal in nature, unused points must be equal in quantity between Analog Input, Digital Input, Analog Output, Digital Output.

Contractor shall provide a minimum of one MSDC controller per mechanical system, as shown on the drawings.

The BAS contractor shall provide and field install al MSDC's specified under this section. Mechanical Equipment manufacturers desiring to provide MSDC type controls as factory mounted equipment, shall provide a separate bid for their product less all controls, BAS/Temperature Control Contractor.

b). All input/output signals shall be directly hardwired to the MSDC. Trouble shooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be used.

c). MSDC shall be in continuous direct communication with the network which forms the facility-wide Building Automation System (BAS). The MSDC's shall communicate with the SDC at a baud rate of not less than 19,200 baud.

2. Non-Volatile Memory

a). All control sequences programmed into the MSDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery to be retained. Power failures shall not cause the MSDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The MSDC shall allow for the creation of unique application control strategies. Systems that allow selection of sequences from the library or table are not acceptable.

b). All control sequences shall be fully field programmable at the MSDC controller, allowing for the creation or editing of an application sequence of operations.

c). Each MSDC shall be provided with manufacturer’s standard built-in Operator Interface.

d). The MSDC shall allow for internal processing and reporting of user defined Time of Day Schedules, Alarms, Trend Reports, Run Time Totalization, Energy Utilization Reports, Application Program Documentation and interface with a peripheral device such as an autodial/autoanswer modem, a VT-100 Display Terminal, or a serial printer.

Systems not providing the above functionality at the MSDC are not acceptable and shall utilize an SDC in place of the MSDC.

e). The MSDC shall provide LED indication of transmit/receive communications performance as well as for the proper/improper operation of the controller itself.

f). The MSDC shall be provided with a battery backed time clock that is capable of maintaining the time of day and calendar for up to thirty days without loss of setting. The battery for the time clock shall be field replaceable by the customer. Integral daily, weekly, holiday and special event scheduling shall be provided, such that all schedules can be custom tailored to the facility. Predefined schedules, with set quantities of on/off cycles are not acceptable.

3. Controller Location

a). To simplify controls, mechanical service and troubleshooting, the MSDC shall be mounted directly in or on the control compartment of the mechanical system. The MSDC shall be provided in a NEMA 1 enclosure to accommodate direct mounting on the equipment to be controlled. The MSDC shall be constructed in a modular orientation such that service of the failed components can be performed quickly and easily. The modular construction should limit the quantities of printed circuit boards to a maximum of three. When required to replace a printed circuit board, it shall not be necessary to disconnect any field wiring. The MSDC shall allow for the creation of, unique, application control strategies. Systems that allow selection of sequences from a library or table are not acceptable. This shall allow all controls maintenance and troubleshooting to be made while at the unit location. MSDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

b). For compatibility to the environment of the mechanical systems, MSDC shall have wide ambient ratings. MSDC shall be rated for service from -40 Deg F (Degrees Fahrenheit) to 140 Deg F.

c). Contractor shall submit description of location for the MSDC's on all mechanical equipment.

G. Unitary Digital Controller (UDC)

1. General

a). Controls shall be microprocessor based Unitary Digital Controllers (UDC's). UDC's shall be provided for equipment as necessary. UDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the UDC. The application control program shall be resident within the same enclosure as the input/output circuitry which translates the sensor signals. All input/output signal conversion shall be performed through a minimum of a 10 bit A to D converter.

Contractor shall provide a minimum of one UDC controller per unitary system as required.

The BAS contractor shall provide and install all UDC's specified under this section. Mechanical equipment manufacturers desiring to provide UDC type controls as factory mounted equipment, shall provide a separate bid for their products less all controls, actuators, valve assemblies and sensors, which are specified to be provided by the BAS/Temperature control contractor.

b). All input/output signals shall be directly hardwired to the UDC. Troubleshooting of input/output signals shall be easily executed with a volt-ohm meter (VOM). As a result of this intent, it is specified that power line carrier systems, or other systems which command multiple outputs over a single pair of wires, shall not be utilized.

c). UDC's shall be in continuous, direct communication with the network which forms the facility wide building automation system. The UDC's shall communicate with the SDC at a baud rate of not less than 9,600 baud.

2. Non-Volatile Memory

a). All control sequences programmed into the UDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the UDC memory to be lost, nor shall there be any need for batteries to be recharge or replaced to maintain the integrity of the controller database. The UDC shall allow for the creation of unique application control sequences. Systems that allow only selection of sequences from a library or table are not acceptable.

b). All control sequences shall be fully configurable at the AHDC, allowing for the creation and change of a sequence while at the unit.

c). The UDC shall be provided with the ability to interface with the HHOT. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the HHOT to have full functionality as described hereinbefore of this specification. From the interface port, the HHOT shall be able to directly access any AHDC, or UDC in the network.

d). The UDC shall provide an input/output point treading utility that is capable of accumulating 48 analog point samples and 10 digital point samples per Input/Output point. Each sample shall be taken on a user defined interval, ranging from 1 second to 255 hours per sample. The digital readings shall be on a change of state occurrence for the digital points. All samples shall be recorded with the engineering units for the value, along with a time and date identifier for each sample taken.

Systems unable to provide the above capability shall provide for the

individual input/output point treading at the SDC. Specifics as to how each UDC point will be trended, at the SDC, shall be provided in the submittal documents. Included in the explanation shall be the sample intervals, the memory allocation in the SDC and the number of UDC's per SDC that can be expected.

e). The UDC shall provide LED indication of transmit/receive communication performance, as well as for the proper/improper operation of the controller itself.

3. Controller Location

a). To simplify controls and mechanical service troubleshooting, the UDC shall be mounted directly in the controls compartment of the unitary system. The UDC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment. The UDC shall be directly wired to sensory devices, staging relays or modulating valves for heating and cooling.

b). For compatibility to the environment of the unitary equipment, UDC's shall have wide ambient ratings. UDC's shall be rated for service from 32 Deg F (Degrees Fahrenheit) to 140 Deg F.

c). Contractor shall submit description of location of UDC's on all mechanical and unitary equipment.

H. Gateway Digital Controller (GDC)

1. General

a). Controls shall be microprocessor based, Gateway Digital Controllers (GDC's). GDC's shall be provided for the purpose of integrating microprocessor based, communicating, direct digital control systems from vendors other than the primary, selected controls manufacturer. GDC's shall be based on a minimum 16 bit microprocessor working from software program memory which is physically located in the GDC. All communications interface control programs shall be resident within the GDC.

The BAS contractor shall provide and field install all GDC's specified under this section. Any interface requirement beyond a two wire communications wire link, shall be provided by the equipment manufacturer supplying the non-primary or third party microprocessor based, communicating, direct digital controllers.

b). All GDC's shall exist at the LAN level with the SDC's. The GDC's shall possess all capabilities described under the SDC section while additionally providing the interface to the third party systems described above. The

GDC's shall communicate with the third party controllers at the highest possible baud rate offered by the third party system. As a minimum, 9,600 baud communications shall be utilized.

c). All control sequences programmed into the GDC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained. Power failures shall not cause the GDC memory to be lost, nor shall there be any need for batteries to be recharged or replaced to maintain the integrity of the controller database. The GDC shall allow the standard database information from the third party system to be integrated in standard FMCS data formats, allowing for the creation of unique application control sequences. Systems that only allow selection of data and sequences from a library or table, are not acceptable.

d). Each GDC shall be provided with manufacturer's standard built-in operator interface.

e). The GDC shall provide Alarming, point trending and Energy report generation capabilities. Alarming points shall be uniquely definable, with multiple alarms assignable to a single point. Such alarm shall be provided with a unique 80 character message. Systems utilizing an alarm message library, shall describe the size of the library and verify how all alarming within the GDC will be guaranteed unique 80 character messages.

The quantities of trended point values shall be limited only by total controller memory space. If necessary, a GDC may be dedicated fully to a trending task, allowing all controller memory to be available for the trend storage. Each unique trend report shall contain a minimum of 4 different points and a minimum of 128 samples per point. Trending frequency for each report shall be operator definable from a sample once a second to a sample once every 24 hours. Trend reports shall be internally formatted by the GDC and shall be reportable directly to a serial printer, a VT-100 display terminal, a CCS, CHS or any other device capable of receiving a formatted ASCII data file.

The energy reports shall not be limited in quantities only by available memory within the GDC. Each Energy Report shall be fully formatted and reportable to a serial printer, a VT-100 display terminal, a CCS, a CHS or any other device capable of receiving a formatted ASCII data file. As a minimum, each Energy Report shall provide a daily report and a monthly report with summary information such as outside air temperature, outside air humidity, total energy consumed and degree day calculations.

f). The GDC shall be provided with a battery backed clock that is capable of maintaining the time of day and calendar for up to thirty days, upon loss of power to the GDC, without loss of setting. The battery for the time clock shall be field replaceable by the customer.

2.9. SYSTEM SOFTWARE DESCRIPTION

A. General

1. Contractor shall provide all software for a complete and operational system as described herein. Software shall include manufacturer's standard multi-tasking, multi-user operating system for operator consoles and controllers, network communication software for dial-up and hard trunk applications, operator man-machine interface software, control application software and all other software necessary to provide the functions specified herein.

2. System software shall be as manufactured by Siebe Environmental Controls, Johnson Controls, Honeywell, Siemens, Alerton or approved equal.

2.10. EXCEPTION REPORTING SEQUENCES

A. Alarm/COS Reports

1. For those digital points indicated on the drawings, the Contractor shall provide a unique change-of-state alarm message of up to 70 characters. The message shall report to all devices assigned to the alarm class.
2. For those points indicated on the drawings which are designated as interrupt priority, the Contractor shall provide an interrupting process display at the CHS location which displays the current conditions for the operator.
   In addition, the CHS computer shall automatically send a picture of the process graphic display to the remote locations specified on the drawings as receiving facsimile copies of interrupting alarms.
3. For those points designated in paragraph 3 above, the FMCS shall also send a history log to the system report printer of the immediate prior history of the points causing the interrupt priority. This log shall contain 1 minutes samples of the previous 15 minutes of operation.
4. For those points on the drawings designed as Hard Facts points, the Contractor shall provide an alarm message to a remote facsimile location designated by the Owner. The FMCS system shall provide at the remote location, a facsimile printout showing location, time/date of alarm and alarm message of the point. For interrupt priority fax alarms, the remote facsimile machine shall receive a hard copy of the interrupt process screen showing on-line dynamic data values of the current conditions.

B. Off Hours Exception Reporting

The Owner shall specify up to five sites to which off hours exceptions shall be auto-dialed and reported. This shall allow the owner to assign off hours exception responses to various facility personnel as necessary. Selection of the site to be dialed can be programmed by the Owner, and set to change automatically per time of day and day of week.

2.11. MONITORING SYSTEM, SENSORS AND WIRING

A. Sensors and other Devices for Input/Output Summary Schedule:

1. Provide all necessary sensors, relays, panels, conduits and wire for the points indicated in the input/output summary as shown on the contract drawings.
2. Analog sensing elements for remote indication shall be independent of local sensors used for local control loops.
3. Temperature sensors shall be Resistance Temperature Detector (RTD) type of 1000 ohm balco. Space (60-90 degrees F); Duct/Well (-30-250 degrees F); Averaging Duct (-30-225 degrees F) or as required under Division 26.

    a). Space temperature sensors shall be provided with blank commercial type locking satin chrome covers.
    b). Duct temperature sensors shall be rigid stem or averaging type as specified in the sequence of operation. Water sensors shall be provided with a separable copper, monel or stainless steel well. Outside air wall mounted sensors shall be provided with a sun shield.
    c). The dew point sensor shall employ a non-reactive organic bobbin material to give precise dew point readings with accuracy of not more than $\pm$ 1.5 degrees F. The dew point sensor shall incorporate an integral draft shield as part of the instrument for air velocities in excess of 50 feet per minute. The dew point sensor shall operate over a minimum dew point temperature range suitable to application.

4. Relative humidity sensors shall be capacitance type with 10 percent to 90 percent range. Duct mounted humidity sensors shall be provided with a sampling chamber. Wall mounted sensors shall be provided with covers identical to temperature sensors. Space 10 percent -90 percent RH; Duct 10 percent - 90 percent RH.
5. Temperature/humidity sensors located in corridors, toilet rooms, and similar assembly type spaces shall be vented fully recessed type with lockable guard.
6. Differential and Static Pressure Sensors and Switches

    a). Fan proof-of-flow switches shall be U.L. listed adjustable set point and differential pressure type. Switches shall be piped to fan discharge except where fans operate at less than one inch WG, they shall be piped across the fan. For fractional horsepower and non-ducted fans, relays or auxiliary contacts may be used. Maximum pressure rating shall be at least 10 inches WG. with .05-12 inch W.C. range.
    b). Pump proof-of-flow switches shall be U.L. listed adjustable differential pressure or flow type as specified in the sequence of operation or data point summary. Devices shall be 150 psi rated except chilled water flow switches shall be provided with totally sealed vapor tight switch enclosure on 300 psi body. Differential pressure switches shall have valved manifold for servicing, and a range of 3 psi-150 psi.
    c). Air flow and static pressure analog sensors shall be high accuracy suitable for the low velocity pressures to be encountered, be selected for approximately 50 percent overrange, and have a 4 to 20 ma output. These differential pressure sensors shall be connected to the air flow measuring station with valved lines for testing and calibration, and shall have adjustments for zero and span. 5 inch W.C. range.

d). Water flow analog sensors shall be provided complete with flow element and shall be an all solid state precision industrial type with stainless steel meter body, maximum error of no more than .5 percent or span, and 4 to 20 ma output. Sensor shall be rated for 250 psi minimum and installed in strict accordance to the manufacturer's instructions complete with three-valve manifold for calibration and maintenance.

7. Overall system accuracy, including electronic analog sensing elements, shall be as follows:

   a). Air: Plus or minus 1.0 degrees F temperature, plus or minus 2.5 percent r.h., plus or minus 2.0 percent static pressure.
   b). Water: Plus or minus 0.7 degrees F over full scale range for chilled water points, plus or minus 1.0 degree F for others.
   c). BTU Calculations: Plus or minus .3 degrees F for chilled water input points.
   d). Proof of fan or pumps operating status, or alarm conditions shall be through positive feedback from differential pressure switches across fan or pump. Auxiliary dry contacts may be used for proof of fans or pumps if the motors are fractional H.P., and other non-ducted fans.

8. Digital inputs from devices with isolated, dry type contacts (no grounds, no voltage) of either normally open (N.O.) or normally closed (N.C.) configuration shall be provided. Live contact inputs, those that have voltage present, shall be provided with isolating devices to meet dry contact requirements.
9. Liquid flow data shall be received and transmitted by commercial grade instrument similar in quality to Honeywell 411, Rosemount, Foxboro, MAMAC Systems or approved equal, type differential pressure transmitter. Pulse type data sensors shall not be acceptable. Speed response of differential pressure transmitters shall be at least 500 milliseconds. Maximum error signal shall be +/- 1 foot.
10. Start-stop relay module shall contain relays for start-stop function at the remote point, with relays mounted and factory wired to numbered terminal strips.
11. Outage Devices:

    a). Control Relays: Control relay contacts shall be rated for the application, with a minimum of two sets of Form C contacts, enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression limiting transients to nondamaging levels.
    b). Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of two sets of Form C contacts enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices to limit transients to nondamaging levels. Delays contact opening or closing shall be adjustable from one to 60 seconds with a minimum accuracy of plus or minus 2 percent of setting.

c). Latching Relays: Latching relay contacts shall be rated for the application with a minimum of two sets of Form C contacts enclosed in a dustproof enclosure. Relays shall have silver-cadmium contacts with a minimum life span rating of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to nondamaging levels.

d). Reed Relays: Reed relays shall be encapsulated in a glass-type container housed in a plastic or epoxy case. Contacts shall be rated for the application. Operating and release times shall be one millisecond or less. Reed relays shall have a minimum life span rating of 10 million operations.

e). Contactors: Contactors shall be of the single-coil, electrically operated, mechanically held type. Positive locking shall be obtained without the use of hooks, latches, or semi-permanent magnets. Contacts shall be double-break silver-to-silver type protected by arcing contacts. Number of contacts and ratings shall be selected for the application. Operating and release times shall be 100 milliseconds or less. Contactors shall be equipped with coil transient suppression devices to limit transients to nondamaging levels.

f). Solid-State Relays: Input-output isolation shall be greater than 1000 megohms with a breakdown voltage of 1500 V rms or greater at 60 Hz. The contact life shall be 10 million operations or greater. The ambient temperature range shall be minus 20 degrees to plus 140 degrees F. Input impedance shall not be less than 500 ohms. Relays shall be rated for the application. Operating and release times shall be one millisecond or less. Transient suppression shall be provided as an integral part of the relay to limit transients to nondamaging levels.

12. Audible Alarm:

a). All alarms shall annunciate on the ATC system front end computer and via pagers.

2.12. MAKE-UP WATER FLOW METER/ALARM

A. In-line T-mounted Flowmeter: Made for installation between pipe flanges; measures flow directly in gallons per minute. As manufactured by Aaliant, Badger, Hersey, Kele, Data Industrial or approved equal.

1.	Construction:	Stainless steel body, with integral transmitter and direct - reading scale.
2.	Pressure rating:	400 psig maximum.
3.	Temperature Rating:	221 F maximum
4.	Display:	Two lines; alphanumeric characteristic each. Visual instantaneous rate of flow, with register to indicate total volume in gallons.
5.	Output:	Two simultaneous outputs; 4 to 20 mA, two-wire, pulse.
6.	Transmitter:	Universal flow transmitter with pulse output (totalization) to convert digital pulses to totalized gallons.

7.	Electronic Housing:	NEMA4, 3/4 NPT conduit connection, epoxy coated aluminum.
8.	Accuracy:	Plus or minus 1 percent of reading.
9.	Key Pad:	Setting of recalibration, engineering units, data logging sample time, alarms, response time.

B. Power and control wiring to be furnished and installed under this Section of Division 15.

2.13. FLOW MEASURING STATIONS

A. Furnish and install an Onicon Model F-1210, Hersey, Kobold or approved equal dual turbine insertion flow sensor complete with hot tap full port ball valve and installation hardware. The dual turbine element shall have counter rotating axial turbine elements, each with its own rotational sensing system, and an averaging circuit to reduce measurement errors due to swirl and flow profile distortion. Paddle type rotors will not be acceptable. Rotational sensing of each turbine shall be accomplished electronically by sensing impedance change and not with magnetic or photo-electric means. Each sensor shall be individually calibrated and tagged accordingly against the manufacturers primary standards which must be accurate to within 0.1 percent and traceable to the U.S. National Institute of Standards and Technology (NIST).

B. The sensor shall have a maximum operating pressure of 400 PSI, maximum operating temperature of 220 degrees F (optional 300 degrees F) and a pressure drop of less than 1 PSI at 17 feet per second flow rate. Flow sensor shall have 100:1 turndown ratio. Accuracy shall be $\pm$ 2 percent of actual reading from 0.4 feet per second to 20.0 feet per second.

C. The sensor shall have integral analog outputs of 0-10 VDC and 4-20 mA current output for connection to the Central Control System. The sensor shall also include three integral frequency outputs, (top turbine, bottom turbine, average frequency) for diagnostic purposes and for connection to peripheral equipment (local display, BTU meter, etc.). All outputs shall be linear with flow rate.

D. The turbine elements shall be made of polypropylene with sapphire jewel bearings and tungsten carbide shafts. The flow sensor shall be constructed of 316 stainless steel with an aluminum electronics enclosure and gasketed cover.

E. Install flow measuring stations with minimum straight lengths of pipe upstream and downstream from sensor as prescribed by manufacturer's written instructions.

F. Make electrical connections to power supply and interlock with ATC system.

G. Calibrate meters for manufacturers requirements.

2.14. BUILDING DEMAND/ENERGY METERING

A. A building demand/energy meter shall be provided and installed under Division 26. Refer to Electrical Specifications/drawings for type and location. The ATC contractor shall provide

all necessary wiring, relays, terminations, etc., as required to interlock meter with ATC system. Building demand shall be reported on ATC central computer.

B. Quantity of Building Demand/Energy Meters shall be as indicted on the Electrical Contract Drawings.

C. At contractor's option building demand meter may be furnished under this Division. Meter shall be Networked N2 Power Meter as manufactured by Enercept or approved equal.

D. Trend monthly energy (KwH) and Demand (Kw) and forward to engineer for one year.

E. A Cat 6 cable shall be provided under Division 26. The cable shall be routed from the meter to the patch panel on the rack.

2.15. WATER METER

A. A building consumption water meter shall be provided and installed under Division 22 Section, *Plumbing Fixtures* and *Plumbing Equipment*. Refer to plumbing sections and drawing for type and location. The ATC contractor shall provide all necessary wiring, relays, terminations, etc., as required to interlock meter with ATC system. Building water flow shall be reported on ATC central computer.

B. At Contractor's option the building water meter may be furnished and installed under this Division.

C. Trend monthly water use (in gallons) and forward to Engineer for one year.

2.16. LEED DISPLAY

A. Furnish and install a LEED display where indicated on the Contract Drawings. LEED display shall consist of a minimum 42 inch touch screen television, personal computer, software, wiring, and devices. LEED display/software shall be QA Graphics "Energy Efficiency Education Dashboard", Johnson Controls' Sustainability Manager, or approved equal.

B. The LEED display shall consist of the following "pages" or "screens":

1. Home Page: The "Home Page" for Delaware Technical & Community College Sustainable Energy Training Center shall indicate the following information:

a). Picture or render of Delaware Technical & Community College Sustainable Energy Training Center along with information about the building.
b). Tabs or Icons that take the user to the other sections of the interactive display.
c). Screen saver mode that will scroll through selected images of the building and its features.

2. Building Education Page: The "Building Education Page" shall indicate the following information:

   a). Building Green Features
   b). Delaware Technical and Community College Information

3. Monitoring Page: The "Monitoring Page" shall indicate a minimum of five (5) icons that shall display the following information:

   a). Geothermal System BTU's
   b). Solar Photovoltaic System Energy Output
   c). Solar Thermal System Output
   d). Domestic Water Consumption – Hot and Cold (gpm and gallons per day)
   e). Electricity Usage (KW & KWH)
   f). Outside Temperature and Humidity
   g). Temperatures and hot water use at solar thermal system.
   h). Energy Recovery Unit.
   i). Variable Refrigerant Flow System.

   This information shall have the historical information displayed through a graph and the live data displayed on a gauge. The historical information will be shown daily, weekly, monthly, and yearly. The historical points shall be shown in a combination of totalization, peak, and average demand.

4. Green Features Page: The "Green Features Page" shall provide the following information:

   a). LEED checklist describing features and some basic information about each feature.
   b). Information on geothermal, solar photovoltaic system, and solar thermal system.

5. Weather Widget Page: The "Weather Widget Page" shall indicate the following:

   a). Current weather conditions and forecasts and will be specific to the Delaware area.
   b). Outside air temperature and relative humidity

6. All pages shall have the following common components:

   a). Navigational bar that will allow the user to link to every screen.
   b). Page title.
   c). Logo of the facility.

C. Interface LEED display with the following devices:

DEVICE	DISPLAY
Geothermal BTU Meter	Daily/Monthly/Yearly BTUs

Main Domestic Water Meter/Domestic Hot Water Meter	Daily/Monthly/Yearly Flow Rate in Gallons
Demand/Energy Meter	Daily kWh, Daily kW, Monthly kWh, Yearly kWh
Solar Photovoltaic System Monitor	Daily kWh, Monthly kWh, Peak Power kW, Yearly kWh, Total kWh, Instantaneous Amps, Volts
Solar Thermal System	Daily, Monthly, Yearly Btu's
Weather Data	Outside Air Temperature and Outside Air Relative Humidity

D. Provide and install all devices, software, wiring, conduit, controls for a fully operational system. Interlock with ATC system devices.

2.17. FIELD INSTALLED CONDENSATE OVERFLOW SWITCHES

A. Condensate overflow switches must be tested to comply with U.L. 508.

B. Interlock condensate overflow switches to shut-down cooling equipment and alarm on ATC system where overflow condition exists.

2.18. CO_2 SENSORS/TRANSMITTER

A. Furnish and install wall mount CO_2 sensor/transmitters at locations indicated on floor plans. CO_2 sensor/transmitter shall be model CD-W00 as manufactured by Johnson Controls or approved equal.

B. Measuring Range: 0 to 2,000 ppm CO_2.

C. Response Time: 1 minute

D. Output Signal: As required by ATC system

E. Max power consumption: Less than 2 watts.

F. Listing: U.L. Listed

G. Accessories: Mounting Kit, Transformer required.

PART 3. EXECUTION

3.1. GENERAL

A. The Automatic Temperature Control System and Central Control and Management System,

shall be designed, installed, and commissioned in a turnkey fully implemented and operational manner.

3.2. BMS SPECIFIC REQUIREMENTS

A. Graphic Displays

1. Provide a color graphic system flow diagram display for each new system with all points as indicated on the point list. All terminal unit graphic displays shall be from a standard design library.
2. User shall access the various system schematics via a graphical penetration scheme and/or menu selection.

B. Custom Reports:

1. Provide custom reports as required for this project:

3.3. INSTALLATION & SUPERVISION

A. All wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent restriction to devices and terminals.

B. The control contractor shall be responsible for all electrical installation required for a fully functional control and automation system and not shown on the electrical plans or required by the electrical specifications. All wiring shall be in accordance to all local and national codes.

1. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications.
2. All electric and electronic wiring shall be minimum #20 AWG minimum THHN and shielded if required.
3. All wiring in the central control room shall be concealed in an approved manner.

C. Verify locations of thermostats, humidistat and other exposed control sensors with plans and Owner prior to installation.

D. The installation and supervision of this project shall be carried out by factory trained personnel who are employed by the Contractor and licensed for this type of work.

E. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.

F. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation.

G. Install in accordance with manufacturer's instructions.

H. Check and verify location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation. Align with lighting switches and humidistats.

I. Mount freeze protection thermostats using flanges and element holders.

J. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

K. Provide separable sockets for liquids and flanges for air bulb elements.

L. Mount control panels adjacent to associated equipment on vibration free walls or free standing angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide engraved plastic nameplates for instruments and controls inside cabinet and engraved plastic nameplates on cabinet face.

M. Install equipment plumb and level.

N. Install all equipment to be accessible for service and maintenance.

3.4. ACCEPTANCE TESTING

A. Point Verification

To verify end-to-end operation of the system the Contractor shall provide a hard copy of an All Points Summary Listing to the Owner of each part or system to be placed in warranty by the Owner. For CHS systems, the Contractor shall additionally provide a print screen of the process display showing real time dynamic point information for all points on the subsystem(s) to be accepted.

B. Sequence Verification

1. The Contractor shall notify the Owner's representative of systems which perform all specified sequences.
2. The warranty acceptance test shall be of 5 days duration and the system shall perform as follows:

a). During the five days, the FMCS system shall not report any system diagnostics from the subsystem under test.

b). The subsystem shall be performance verified as operational using temporary trends of each control loop located in the SDC or MSDC.
During the occupied periods, BAS control loops, under test, shall maintain control of the process variable within the following scales:

Duct Static Pressure	+/-0.3 inch WC
Pump Head Pressure	+/-10 percent of control range

Duct Temperature Loops	+/-2 degrees F
Room Temperature Loops	+/-1degrees F
Pipe Temperature Loops	+/-2 degrees F
Duct Humidity	+/-2x rated error of Humidity Transmitter

The contractor shall provide a hard copy printout of the process variable, process variable set point and control loop output percent for the period of 2 hours prior to occupancy to 2 hours after occupancy with samples taken every 15 minutes.

3.5. COORDINATE WITH TAB AGENCY

A. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water reset, freeze stats and duct smoke detectors.

B. Verify that all controlling instruments are calibrated and set for design operating conditions prior to commencement of TAB work.

C. Calibrate sensors after installation, and before the sensor control verification tests are performed. Prove the accuracy of final settings by taking temperature readings. The readings shall be in a typical conditional space for each separately controlled zone.

D. Allow sufficient time in the project to provide assistance and instruction to the balancing agency in the proper use and setting of control components such as, but not limited to, computers, static pressure controllers, or any other device that may need set points changed so that the testing and balancing work can be performed.

E. All control sequences, software, equipment, and components shall be started-up by a qualified technician. Start-up report shall be submitted to Engineer prior to the commencement of testing and balancing work. Testing and balancing shall not commence until start-up reports are completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

3.6. EXAMINATION

A. Verify existing conditions before starting work.

B. Verify that systems are ready to receive work.

C. Beginning of installation means installer accepts existing conditions.

D. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.

E. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

F. Coordinate installation of system components with installation of mechanical system equipment such as air handling units and air terminal units.

G. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and tubing is installed prior to installation proceeding.

3.7. INTERLOCK REQUIREMENTS

A. The fan and equipment interlock requirements are as scheduled on the contract drawings.

B. Furnish and install all necessary relays, transformer, contactors, wiring, conduit, and accessories to perform fan, equipment, and damper interlocks.

C. Unless otherwise noted, fan interlocks shall be arranged such that dampers associated with fan shall be open when fan starts and close when fan stops.

3.8. SUBMITTALS AT PROJECT CLOSEOUT

A. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

3.9. CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

1. Install piping adjacent to machine to allow service and maintenance.

B. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

C. Connect hand-off-auto selection switches to override automatic interlock controls when switch is in hand position.

3.10. 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 of 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 flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
6. Check temperature instruments and material and length of sensing elements.
7. Check control valves. Verify that they are in correct direction.
8. 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.

E. All temperature control and interlock wiring shall be installed in conduit unless otherwise noted on the plans. Power or interlock wiring shall be run in separate conduit from sensor and communications wiring.

3.11. ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog

instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:

    a). Check analog inputs at 0, 50, and 100 percent of span.
    b). Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c). Check digital inputs using jumper wire.
    d). Check digital outputs using ohmmeter to test for contact making or breaking.
    e). Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.

5. Flow:

    a). Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b). Manually operate flow switches to verify that they make or break contact.

6. Pressure:

    a). Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b). Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

7. Temperature:

    a). Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b). Calibrate temperature switches to make or break contacts.

8. Stroke and adjust control valves and dampers.
9. Provide diagnostic and test instruments for calibration and adjustment of system.
10. 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.

3.12. ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

3.13. SCHEDULING

A. Submit spreadsheet to Owner indicating occupied/unoccupied times for each item controlled by ATC system. Incorporate all scheduling requirements into sequence of operation.

3.14. STAGING

A. Coordinate staging requirements with equipment being controlled. Where multistage units are scheduled or specified, provide all devices, controllers, wiring to control and sequence all stages.

PART 4. SEQUENCES OF OPERATION

4.1. ELECTRIC DOMESTIC HEAT PUMP HOT WATER HEATER WITH RE-CIRC PUMP.

A. General

1. The electric domestic heat pump hot water heater shall be tied into the ATC system to provide start/stop optimization and control. ATC contractor shall provide contactors as required for start/stop optimization.
2. The leaving water temperature of each water heater shall be monitored and report back to central monitoring system.
3. Each domestic hot water heater re-circ pump shall be controlled by a line mounted aquastat. All wiring, relays, aquastats, etc., shall be provided and installed by ATC subcontractor. Domestic water re-circulating pumps shall be de-energized when system is shut-down during summer and/or lengthy unoccupied periods.
4. On a fall in recirc. water temperature below set point the recirc. pump shall energize. Reverse sequence shall occur when aquastat is satisfied.
5. Provide and install differential pressure switch or current sensor to determine the status of all domestic re-circ pumps.
6. Install a domestic recirc. temperature sensor for start/stop optimization.

B. System Operation

1. Each electric domestic heat pump water heater shall be furnished with factory package controls to maintain a constant leaving temperature of 110 degrees F (adjustable).

2.

4.2 AUXILIARY EXHAUST FAN AT BIOFUEL TECHNOLOGY (EF-1)

A. General

1. Whenever the exhaust air fan is energized, associated motor operated damper, D-1 shall be in wide open position.
2. Whenever exhaust air fan is energized ERV exhaust damper (D-2) shall shut.
3. The motor operated damper shall fail in the closed position.
4. Provide differential pressure sensor or current sensor to determine status of each exhaust air fan.

B. Manual Control:

1. The auxiliary exhaust fan is provided to increase ventilation rate at users discretion when odors are produced in the space served.
2. A timed wall switch, WS-1, provided and installed by the Electrical Contractor shall provide users with the ability to manually energize each exhaust fan. When wall switch is energized, the exhaust air damper, D-1 shall modulate to wide open position. The exhaust air fan shall then energize and run continuously for a timed period (60 minutes adjustable), ERV exhaust damper (D-2) shall shut.
3. The reverse sequence shall occur when wall switch is de-energized.
4. Wiring from wall switch to fan shall be installed by the Electrical Contractor. Control wiring from fan to motor operated damper shall be installed by the ATC Contractor.

4.3 HIGH TEMPERATURE ALARMS.

A. General

1. The I.T. Rooms shall be provided with temperature sensors tied into the DDC system.
2. Coordinate temperature sensor alarm set points with Owner.
3. Temperature sensor alarm set points shall be fully adjustable.

B. Operation

1. Install a temperature sensor in the I.T. Rooms set to alarm if it's high temperature setting is exceeded.
2. If the high temperature setting of spaces is exceeded then an audible and visual alarm with silent switch shall sound an alarm on the ATC system.

4.4 ENERGY RECOVERY VENTILATOR WATER COOLED GEOTHERMAL SYSTEM (ALTERNATE)

A. General

1. Energy recovery ventilator (ERV) shall be started and stopped through the CCMS system by way of optimum start-stop program (with manual override). ERV shall be energized during all occupied periods.
2. ERV supply fan, ERV exhaust fan and ERV wheel shall be interlocked to operate during all occupied periods.
3. When the ERV is de-energized, the outside air damper, D-1 and exhaust air damper, D-2 shall close, the energy recovery wheel shall stop rotating, the water side control valve, V-1 shall close and the packaged heat pump refrigeration system shall de-energize whenever the supply air fan is de-energized.
4. The ERV unit dampers shall be provided with end switches to prevent operation of ERV supply fan and ERV exhaust fan until dampers are proven open.
5. When the outside temperature (as sensed by T-OA) is 45 degrees F or below, the freeze protection pump shall be energized to run continuously whether the ERV supply air fan is on or off. When the outside air temperature rises to 48 degrees F, the freeze protection pump shall be de-energized. Provide a differential pressure sensor or current sensor to determine status of the freeze protection pump.
6. A duct mounted smoke detector DD-1 (Provided under Division 26) shall be mounted in the discharge duct and exhaust duct of the ERV. Upon detection of products of combustion, the ERV shall shut down and a signal shall be sent to the fire alarm system. The electrical contractor shall run signal wiring from the smoke detectors to the fire alarm system. The wiring from the smoke detectors to fans shall be by the ATC contractor.
7. Provide differential pressure sensors (or motors current sensors) to determine the status of all fans associated with the ERV.
8. Provide differential static pressure sensors to determine filter loading of the ERV exhaust and supply filters.
9. Provide frost control temperature sensor, T-5.
10. The building exhaust air temperature shall be monitored by temperature sensor, T-4.
11. The wheel discharge air conditions shall be monitored by temperature sensor, T-3 and humidity sensor H-3.
12. All set point temperatures shall be re-settable and adjustable through software. All temperature sensors, differential pressure sensors, valves, freeze protection pumps, and duct detectors shall be monitored locally and on the central ATC system.
13. During cooling mode, the units, packaged refrigerant reversing valves shall divert refrigerant such that the air side coil operates as an evaporator and the waterside coil operates as a condenser. During the heating mode, the unit's packaged refrigerant reversing valves shall divert refrigerant such that air side coil operates as condenser and the water side coil acts as an evaporator.
14. The 2-way two position ATC control valve, (V-1) shall open anytime refrigerant circuit is energized and close whenever refrigerant circuit is de-energized. Provide

time delay that allows ATC control valve V-1 to be wide open prior to compressor operation.

15. Hot gas re-heat coil shall not be enabled during mechanical heating mode.
16. Packaged micro-processor shall determine heating/cooling modes, temperature set points, and humidity set point.
17. Interlock A/C condensate overflow switch to de-energize unit and alarm on ATC system should an overflow condition occur in the cooling coil drain pan.
18. Compressor status via a current switch shall be monitored on ATC system for each heat pump compressor.
19. Interlock air flow monitoring station with ATC system.
20. The energy recovery unit shall be provided with factory packaged controls as indicated in Division 23 Section, "Heating, Ventilating, and Air Conditioning Equipment". Refer to Division 23 Section, "Heating, Ventilating, and Air Conditioning Equipment" for packaged controls.
21. ATC subcontractor shall install interlock wiring, thermostats, and control wiring for a complete and operational system.
22. The ATC subcontractor shall install and interlock A/C condensate overflow safety switches to their respective energy recovery ventilators. The condensate overflow safety switches shall be wired to de-energize the energy recovery ventilator in the case of high level water condition. A local alarm shall be annunciated upon activation of pump safety switch. Field install the A/C condensate overflow safety switches in the cooling coil drain pan. Condensate overflow safety switches shall be U.L. 508 listed.
23. A global outside air carbon dioxide sensor shall be monitored and trended on the ATC system to allow re-set of CO2 sensor set points based on outside air CO2 levels.
24. Under this division install and interlock global CO2 detector and space CO2 detectors with ERV.
25. Under this Division, install ERV provided space humidity sensor and interlock with ERV unit for control of humidity and hot gas re-heat.
26. Under this Division install all interlock wiring between ERV unit and ATC system.
27. Refer to point list on Contract Drawings for additional monitoring requirements.
28. Should the space carbon dioxide or exhaust air carbon dioxide levels vary by more than 10% or more from the design values an audible/visual alarm shall sound on ATC system. Alarm shall have a 10 minute delay (adjustable).
29. Should the outside air flow as sensed by air flow monitoring station vary by more than 10% or more from the design values an audible/visual alarm shall sound on ATC system. Alarm shall have a 10 minute delay (adjustable).
30. Furnish and install a flow switch (FS) in the geothermal return pipe. Flow switch shall be interlocked to prevent compressor operation until flow is proven.

4.5 ENERGY RECOVERY VENTILATORS AIR COOLED SPLIT SYSTEM (ALTERNATE)

A. General

1. The Energy Recovery Units shall be provided with factory packaged controls as indicated in Division 23 Section, *Heating, Ventilating, and Air Conditioning Equipment*. Refer to Division 23 Section *Heating, Ventilating and Air Conditioning Equipment* for Packaged Controls. Furnish controls as required under this Division to accomplish operation adjustment, and monitoring as required.

2. Duct mounted smoke detectors shall be mounted in the discharge supply duct and exhaust air duct of the unit. Upon detection of products of combustion, the supply air fan, and interlocked exhaust air fan shall shut down and a signal shall be sent to the fire alarm system. Duct detectors shall be furnished under Division 28 and installed under Division 23.

3. ATC subcontractor shall install interlock wiring, humidity sensors, CO2 sensors, thermostats, and control wiring for a complete and operational system.

4. The ATC subcontractor shall install and interlock A/C condensate overflow safety switches to their respective energy recovery ventilators. The condensate overflow safety switches shall be wired to de-energize the energy recovery ventilator in the case of high level water condition. Field install the A/C condensate overflow safety switches in the cooling coil drain pan. Condensate overflow safety switches shall be U.L. 508 listed.

5. A global outside air carbon dioxide sensor shall be monitored and trended on the ATC system to allow re-set of CO_2 sensor set points based on outside air CO_2 levels.

6. Under this division install and interlock global CO2 detector and space CO2 detectors with ERV.

7. Under this Division, install ERV provided space humidity sensor and interlock with ERV unit for control of humidity and hot gas re-heat.

8. Refer to point list on Contract Drawings for additional monitoring requirements.

9. Refer to Division 01 *Alternates*.

10. All items on point list must be monitored on the ATC system.

11. Under this Division install global outside air humidity and temperature sensors and monitor on the ATC system.

12. Under this Division install exhaust air temperature and humidity sensors and monitor on the ATC system.

13. Under this Division monitor the variable frequency drive fan speeds and amperages

on the ATC system.

14. Under this Division, install graphics for ERV system and display all points on the ATC system.

15. Under this Division, install current sensors on ERV unit compressors and monitor on the ATC system.

16. Under this Division, install energy recovery wheel rotation sensor and monitor on the ATC system.

17. Under this Division install air flow monitoring station in outside air supply duct and monitor on ATC system.

18. Provide frost control temperature sensor, T-5.

19. Should the space carbon dioxide or exhaust air carbon dioxide levels vary by more than 10% or more from the design values an audible/visual alarm shall sound on ATC system. Alarm shall have a 10 minute delay (adjustable).

20. Should the outside air flow as sensed by air flow monitoring station vary by more than 10% or more from the design values an audible/visual alarm shall sound on ATC system. Alarm shall have a 10 minute delay (adjustable).

4.6 CENTRAL GEOTHERMAL WATER SOURCE HEAT PUMP SYSTEM

A. The central geothermal heat pump system shall be started and stopped by a signal from the CCMS. Provide a panel mounted hand-off-auto (H-O-A) switch that overrides the CCMS to manually start or stop the central geothermal heat pump system. The CCMS shall have control of the central geothermal heat pump system operation when the panel mounted H-O-A switch is in the *"auto"* position.

B. The central geothermal heat pump system shall be enabled at all times that at least one compressor is energized to provide continuous circulation of the central ground source loop fluid. In the event of a power outage, provide an interlock that will not enable heat pump compressors to energize when power is restored until the main pump is at full speed as determined by differential pressure sensor. Once full flow is established then heat pumps shall be enabled to operate. If all compressors in the system are de-energized either due to setback temperature or because load is satisfied, then the geothermal pump shall be de-energized. Once a compressor is commanded on the lead geothermal pump shall energize and soft start. Equipment compressors shall not be allowed to energize until flow is established as indicated by equipment flow switches.

C. ATC system shall determine the primary (lead) and standby status of each pump and interlocks to the selected pumps. All input and output points listed on the CCMS point schedule that are connected through a control panel provided by the ATC subcontractor,

shall be wired through dedicated terminal strips. Digital output (DO) control points shall be a 24 VAC max signal provided by the CCMS to the ATC control panel to drive a pilot relay.

D. Provide software automatic alternator for lead/lag pump control of both pumps. Only one pump shall run at one time. If the lead pump fails as sensed by differential pressure sensor or ATC system, the lag pump shall energize after a 15 second time delay and an audible and visual alarm with silence switch shall sound "on" the EMS. The system shall automatically rotate lead/lag assignment every week, adjustable through software.

E. The differential pressure sensor set point for the variable speed driven pumps shall be field determined. Set point shall be based on maintaining minimum pressure to overcome resistance of any coils, control valve, and runout pipe/fittings. The final differential pressure sensor set point value shall be documented on the as-built ATC drawings.

F. Provide temperature sensors TS-1 and TS-2 to monitor the leaving and entering fluid temperatures of the vertical U-tubes. In addition, should the loop temperature as measured at temperature sensor TS-1 exceed 100 degrees F (adjustable) in heat rejection mode or drop below 38 degrees F (adjustable) in heat absorption mode, then an alarm shall sound. An audible and visual alarm with silence switch shall annunciate upon activation of the alarm condition.

G. The lead pump shall vary system flow through pump variable speed drive to maintain differential pressure controller set point. Differential pressure sensor/transmitter shall be commercial grade quality, intelligent type, Rosemont Model 1151, DP, Foxboro or approved equal. Differential pressure set point shall be adjustable through the Emergency Management System. The differential pressure sensor/transmitter shall be located as shown on the contract documents.

H. Provide a make-up water flow meter/alarm that shall, upon detection of flow (field determined) send an alarm to the central station monitoring system notifying the Owner that flow is being produced through the meter. Upon manual reset at the flow meter the alarm shall cease and the system return to normal status. The CCMS shall keep record of total number of gallons that have passed through the make-up water flow meter/alarm.

I. All modes, temperature set points, alarms, schedules, pressure settings, etc., shall be fully adjustable and resettable.

J. Two (2) position ATC control valves (V-1) at each unit shall open/close as indicated in the unit's individual automatic temperature control sequence.

K. Pump speed and amperage for all pumps shall be monitored/trended on the automatic temperature control system.

L. The geothermal system water loop shall be provided with a flow measuring station (FMS). The flow measuring station shall monitor the geothermal system rate in gallons per minute and shall display the value on the ATC system computer. Provide Algorithm in ATC system

program to perform and display BTU calculations. Interlock with LEED display.

M. Provide an interlock that will maintain minimum flow at main pumps by opening remote control valves of heat pumps. Should pump flow rate approach the minimum flow rate then ATC system shall open heat pump control valves as required to maintain minimum flow rate.

N. Minimum Flow Provision: Utilize the readout of the flow measuring station to prevent pump operation below the scheduled minimum flow rate. Whenever, the ground loop pump approaches the minimum schedule flow rate in gpm, the ATC system shall energize minimum flow provision. The minimum flow provision shall open control valves closest to the pumps to maintain a total minimum flow rates as scheduled.

4.7 VARIABLE REFRIGERANT VOLUME SPLIT SYSTEM WATER COOLED SYSTEMS

A. The variable refrigerant volume split system shall be provided with factory furnished controls as indicated in Division 23 Section, *Heating, Ventilation, and Air Conditioning*.

B. ATC Subcontractor shall install factory furnished controls, interlock wiring, thermostats, and control wiring for a complete and operational system.

C. ATC Subcontractor shall interlock the A/C condensate float switch to their respective ductless split system indoor unit. The A/C condensate float switch shall be wired to de-energize the indoor unit if moisture is detected in the auxiliary drain pan. A remote alarm shall be annunciated upon activation of the float switch, through the ATC system.

D. When compressor unit energizes its two (2) position, 2-way ATC valve (V-1) shall open to provide continuous fluid flow. The reverse sequence shall occur when the compressor unit is de-energized.

E. Refer to point list on Contract Drawings for additional monitoring requirements.

F. Furnish and install a flow switch (FS) in the return pipe of each compressor unit (typical of 3). Flow switch (FS) shall be interlocked to prevent operation of compressor until flow is proven.

G. Provide supply (TS-1) and return (TS-2) water temperature sensors to each compressor unit (typical of three (3) compressor units). Temperature shall be monitored and trended.

H. Interlock A/C condensate pump with ATC system to alarm should an overflow condition occur.

I. Provide occupied and unoccupied scheduling that will allow the variable refrigerant volume split system to be de-energized during unoccupied periods. During unoccupied periods the variable refrigerant volume split system shall only be energized if any unoccupied or setback temperature is not met. Once the unoccupied or setback temperatures are met in all zones the variable refrigerant volume split system shall be de-energized. Provide interlock that will energize and soft start main geothermal pump anytime at least one compressor in the system

is enabled. If all loads are satisfied during unoccupied or night set back conditions the main geothermal pump shall de-energize.

4.8 THERMAL SOLAR GRAVITY DRAINBACK SYSTEM

A. General

1. The thermal solar gravity drainback system shall be provided with a microprocessor based differential temperature controller and matching temperature sensors.
2. Under this section of Division 23 specifications provide all interlock wiring, mounting of the controller, mounting of the sensors, interlock wiring to pumps, sensor wiring, as required for a complete operating system.

B. Monitoring:

1. Under this division furnish and install additional solar return temperature sensor and solar supply temperature. Monitor both temperatures on the ATC system.
2. Under this division furnish and install a water meter with ATC interlock capabilities on the cold water feed to the solar storage tank.
3. Provide algorithm in ATC system program to perform and display BTU calculations. Interlock with LEED display.

END OF SECTION

DIVISION 23
SECTION 23211333
GROUND LOOP HEAT PUMP PIPING
TABLE OF CONTENTS

SECTION 23211333 - GROUND LOOP HEAT PUMP PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Exterior piping for horizontal, closed-loop, ground-source heat exchanger systems.
2. Exterior piping for vertical, closed-loop, ground-source heat exchanger systems.

B. Related Sections include the following:

1. Division 23 Section *HVAC Piping, Fittings and Valves* for Interior Geothermal Energy Recovery Piping.
2. Division 23 Section *Heating, Ventilating and Air Conditioning Equipment* for Geothermal Heat Pump Equipment.
3. Division 23 Section *"Earthwork"*.

1.3 REFERENCES

A. Industry Standard And Specifications

1. International Ground Source Heat Pump Association (IGSHSPA):

   a. Closed-loop/Geothermal Heat Pump Systems, Design and Installation Standards.
   b. Closed-loop/Ground Source Heat Pump System, Installation Guide.
   c. Grouting Procedures for Ground Source Heat Pump Systems.

2. American Society for Testing and Materials (ASTM):

   a. ASTM D 2239-96a Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
   b. ASTM D 2657-97 Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
   c. ASTM D 2683-98 Specification for Socket-Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.

d. ASTM D 2774-94 Practice for Underground Installation of Thermoplastic Pressure Piping.
e. ASTM D 3035-95 Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
f. ASTM D 3261-97 Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
g. ASTM F 645-95 Guide for Selection, Design and Installation of Thermoplastic Water Pressure Piping Systems.

1.4 DEFINITIONS

A. GHEX: Closed-loop, ground-source heat exchanger.

B. PE: Polyethylene plastic.

1.5 SUBMITTALS

A. Product Data: Include manufacturer's catalogue sheets, specifications, and installation instructions for GHEX piping, closed cell insulation, and grout material. Include piping type, schedule, class of pipe and fittings.

B. Shop Drawings: Diagram vertical and horizontal piping and interface with interior header piping within building.

C. Calculations: Grout volume calculations and flushing/purging flow rates and pressure drops.

D. Samples: Furnish 12 inch long sample of GHEX piping illustrating U-bend fitting and joining.

E. Quality Control Submittals:

1. Geothermal System Installer's Qualifications Data:

a. Name of each person who will be performing the geothermal work and their employer's name, business address, telephone number, fax number and e-mail address.
b. Names and addresses of three similar projects that each person has worked on.
c. Copy of installer's personal certification for polyethylene pipe fusion techniques from IGSHPA or piping manufacturer.

2. Geothermal System Supervisor's Qualifications Data:

a. Name of person overseeing the geothermal work and their name, business address and telephone number.

b. Name and address of three similar projects that the supervisor has overseen during the past five years.
c. Copy of supervisor's personal certification for polyethylene pipe fusion techniques from IGSHPA or piping manufacturer.

3. Geothermal System Contractor's Qualifications Data

a. Name and addresses of three geothermal projects of similar size and complexity that the supplier has worked on during the past five years.

4. Company Field Advisor Data:

a. Name, business address and telephone number of Company Field Advisor secured for the required services.
b. Certified statement from the company listed the qualifications of the Company Field Advisor.
c. Services and name of each product for which authorization is given by the Company, listed specifically for this project.

F. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.6 QUALITY ASSURANCE

A. Geothermal System Installer Qualifications: The person performing geothermal work shall be personally certified in polyethylene pipe fusion techniques by IGSHPA or piping manufacturer, personally experienced in geothermal work, and shall have been regularly employed by a company performing geothermal work for a minimum of three years.

B. Field Advisor Qualifications: IGSHPA certified installer or IGSHPA certified designer shall qualify as Field Advisor.

C. Geothermal System Supervisor's Qualifications: The persons overseeing the geothermal work shall be personally certified in polyethylene pipe fusion techniques by IGSHPA or piping manufacturer, personally experienced in geothermal work, and shall have been regularly employed by a company performing geothermal work for a minimum of three years.

D. Geothermal System Supplier Qualifications: The contractor shall have completed geothermal work on at least three projects of similar size and complexity within the last five years.

E. Company Field Advisor: Secure the services of a Field Advisor for a minimum of 12 working hours for the following:

1. Render advise regarding installation and final adjustment of the system.
2. Witness on site bore hole locations in the presence of the Owner's representative.
3. Certify that vertical bore holes meet design depth, and do not exceed a 5% differential in depth from one bore hole to another.
4. Witness pressure testing of horizontal and vertical underground polyethylene piping, in the presence of the Owner's representative.
5. Witness the back-filling of horizontal pipes trenches.
6. Witness final system test, then certify with an affidavit that the system is installed in accordance with the Contract Documents and is operating properly.

F. Regulatory Requirements:

1. Perform factory testing of factory fabricated equipment in complete accordance with the agencies having jurisdiction.
2. Perform field testing of piping systems in complete accordance with the local utilities and other agencies having jurisdiction and a specified.

1.7 COORDINATION

A. Coordinate GHEX piping installation with exterior utilities, structures and site work.

B. Coordinate GHEX piping with interior GHEX piping at headers within mechanical room. Coordinate terminations locations within mechanical room. Verify that GHEX piping can be installed to comply with original design and referenced standards.

1.8 DELIVERY, STORAGE AND HANDLING

A. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.

B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

C. Protect flanges, fittings, and specialties from moisture and dirt.

D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.9 PROJECT CONDITIONS

A. Existing Utilities: do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer written permission.
3. Prior to excavation of well drilling, provide test pits to locate existing utilities where geothermal U-tubes and horizontal piping are to be installed.

B. Temporary Facilities: Provide temporary well when required to provide water for well drilling operations. Well size, depth, and location shall be determined based on requirements to allow well drilling operations. Furnish and install the following:

1. Permits for temporary well.
2. Temporary electric service and/or generator.
3. Freeze protection of well head.

C. Remove temporary well and all associated equipment, wiring, and piping at completion of well field installation.

D. Provide and pay for all necessary permits for this portion of the project.

1.10 WARRANTY

A. Manufacturer's Warranty: Minimum 50 years warranty for PE piping and butt fusion welds.

B. Manufacturer shall replace or repair PE piping that fails within the 50 year warranty period due to defects in the piping.

1.11 LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

1.12 ALTERNATES

A. Refer to Division 01 Section, “Alternates” for description of work under this section affected by alternates.

PART 2 PRODUCTS

2.1 VERTICAL U TUBES

A. PE Pipe: ASTM D 3035, made of PE 3408 compound, with dimension ratio not greater than DR 11, to provide pressure rating of at least 160 psig (1104 kPa) at 73 deg F (23 deg C). Provide with UV stabilizer.

1. PE Fittings: ASTM D 3261, PE butt-fusion-type fittings made of PE compound similar to PE pipe, matching pipe OD, and with pressure rating at least equal to PE pipe. Provide with UV stabilizers.
2. Markings: Pipe shall be marked with manufacturer's name and product name, nominal size, ASTM dimensional standard, PPI material classification, cell classification, sequential footage, and manufacturer's date code. Print line shall repeat every two feet.

2.2 DIRECT BURIED HORIZONTAL PIPING

A. ASTMD 3035, made of PE 3408 compound, with dimension ratios no greater than DR 11.0 to provide pressure ratio of at least 128 psig at 73 degrees F. Provide with U.V. stabilizer.

1. PE Fittings: ASTM D 3261, PE butt-fusion-type fittings made of PE compound similar to PE pipe, matching pipe OD, and with pressure rating at least equal to PE pipe. Provide with UV stabilizers.
2. Markings: Pipe shall be marked with manufacturer's name and product name, nominal size, ASTM dimensional standard, PPI material classification, cell classification, sequential footage, and manufacturer's date code. Print line shall repeat every two feet.

2.3 THERMALLY ENHANCED GROUT

A. Geothermal grout consisting of specially blended, high -solids bentonite and sand in a two-part thermally conductive grouting material. Paddle mix grout with minimum shearing action and agitation of the slurry.

B. Geothermal grout, low permeability 1×10^{-7} cm/sec, 65 to 70% solids as manufactured by CETCO, Baroid, or approved equal.

C. Minimum thermal conductivity (k) = 1.2 BTU/HR-Ft -degrees Fahrenheit.

D. Grout sand shall be 50 to 70 mesh with 99% silicia content. Sand shall be ANSI/NSF Standard 60 certified.

2.4 CLOSED CELL INSULATION

A. Closed Cell Insulation: one (1) inch thick, high density (5lb/cu ft), pre-formed pipe insulation of rigid, expanded, closed cell structure. Comply with ASTM C1126, Type III, Grade 1.

2.5 BACKFILL SAND

A. The first 24 inches of backfill adjacent to the horizontal piping shall be backfill sand that shall comply with ASTM C-33. Refer to detail on Contract Drawings.

B. Sand shall be free of rocks, clumps, and other debris.

PART 3 EXECUTION

3.1 EXAMINATION

A. Prior to any excavation, trenching or drilling, all buried utilities, drainage systems, irrigation systems shall be located and flagged by the appropriate utility and contractor representatives.

B. Remove and re-install all fences, structures and similar existing obstructions that impede the installation of the underground piping.

3.2 HORIZONTAL GHEX SYSTEM INSTALLATION

A. Separate trenches by 10 feet (3 m) minimum. Remove sharp rocks in trenches that could contact pipe.

B. Utilize excavated soils or sand for bedding of piping.

C. Backfill to 24 inches (600mm) above pipe with sand. Backfill from sand to grade with excavated soil, compact as required.

D. Clean PE pipe and fittings for loop. Minimize number of joints.

E. Install PE piping in trenches according to ASTM D 2774 or ASTM F 645.

F. Purge, flush, and pressure test piping before backfilling trenches.

G. Install piping in pipe trenches after cushion material bedding has been placed and completed.

1. Minimum Pipe Depth: 48" below finished grade.
2. Insulate piping at wall penetrations, within 5 feet of building, below sidewalks or where located below building.

H. Separate supply and return lines or bundles a minimum of 6-12 inches to minimize thermal interference.

I. Minimize the number of points where supply and return lines cross one another.

J. Install piping of such lengths to minimize the number of fusion joints required.

K. Avoid sharp bends in piping, use elbows where required.

L. Install bell reducing fittings or reducing tees at pipe reductions to eliminate trapped air.

M. Cap open end of pipe to prevent entry of contaminants until final connections are made.

N. Pressure test piping after connecting to vertical well piping.

O. Route horizontal piping around drip lines of trees.

P. Where excavations are over 5 feet deep, provide sloped walls of trenches per OSHA requirements.

3.3 VERTICAL GHEX SYSTEM INSTALLATION

A. Clean PE pipe and fittings for loop. Minimize number of joints.

B. Install PE piping in wells according to ASTM D 2774 or ASTM F 645.

C. Purge, flush, and pressure test piping before grouting well.

D. After installation of loop pipe in well, pump grout to discharge at base of well. Fill well with grout to surface. Owner's representative shall be notified for inspection upon completion of grouting. Document results in writing and submit to Architect.

E. The holes or bores shall be clean and of sufficient diameter to facilitate the installation of the U-tube assembly. Reasonable care shall be taken not to crush, cut or link the pipe. If damaged, it shall be repaired, at no additional cost to the Owner.

F. Remove all cutout material remaining in well from drilling process before installing well piping.

G. Vertical piping shall be factory assembled:

1. Manufacturer shall construct down-hole closed-loop piping from two continuous lengths of pipe with U-bend joints at the bottom of the well.
2. Manufacturer shall mark piping in one foot (1) increments and stencil on the piping the total distance from each increment to the U-bend. This will be accomplished so that the Engineer/Owner can verify depth of wells after piping is installed.
3. Manufacturer shall hydrostatically test the assembled vertical piping at 1.5 times the maximum working pressure, but not less than 125 psig, for four hours.
4. Manufacturer shall cap piping assembly before shipment

H. Provide fittings required for pressure testing.

I. Immediately after insertion into well, fill piping with water until it runs clean. The water in piping is intended to counteract the buoyancy effect. Attach additional counterweights as necessary to bottom of piping for deep wells.

J. Cap upper ends of well piping until connection to horizontal manifold is made.

K. Pressure grout well hole from bottom up with bentonite clay grout in accordance with IGSHPA installation manual. Monitor each well and continue adding grout where settlement has occurred.

L. Connect vertical piping to horizontal manifolds and pressure test entire underground system, before back-filling trenches.

M. Pipe Joint Makeup:

1. Polyethylene Butt or Saddle (side wall) Fusion Pipe Joints: Follow the manufacturer's printed installation instructions.
2. Dissimilar Pipe Joints:

    a. Joining Dissimilar Threaded Piping: Make-up connection with a threaded coupling or with companion flanges.
    b. Joining Dissimilar Non-Threaded Piping: Make-up connection with adapters recommended by the manufacturer's of the piping to be joined.

N. Casing: Where installing vertical U-tubes in rock, install steel casing.

O. Layout wellfield so that drilling equipment is at least 15 feet away from building structure.

3.4 JOINT CONSTRUCTION

A. Clean PE pipe and fittings and make heat-fusion joints according to ASTM D 2657.

B. The fusion machine shall encompass the following features:

1. Guide rods shall be in the plans that passes through the centerline of the pipe thus canceling the bending forces in the machine caused by the fusion forces.
2. The combination butt/saddle machine must have a mechanical advantage of at least 5.5 to 1 in the butt fusion mode, and 2.5 to 1 in the saddle fusion mode. A butt fusion only machine shall have a mechanical advantage of at least 10 to 1 and saddle fusion only machine must be capable of applying at least 600 lbs of thrust.
3. The pipe clamps shall have the strength to "round-up" the pipe closed to the fusion joint. They shall be adjustable for removal of high/low mismatch of pipe walls, and clamp each piece on the continuing straight centerline.
4. The pipe facing device shall be capable of rapid facing of the pipe ends to a perfectly flat surface, so when the ends are brought together, there is 100% plastic contact. The facer shall be hand-powered for pipe sizes up to 2", electrically powered up to 8", and hydraulically powered for sizes larger than 8". The facer

shall have precisely machined stops to lock the facer squarely between the clamping jaws at the end of face off.

5. The heater plate shall be electrically heated and thermostatically controlled. The surface shall be smooth with a high quality non-stick coating. The heater shall be capable of quick heat-up and maintaining a constant surface temperature in the desired temperature range even in inclement conditions. The heater plate shall be equipped with a thermometer to monitor proper temperature.

C. No joints in vertical tubing; maximum two joints at return U-bend.

3.5 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect GHEX system piping to headers within mechanical rooms.

3.6 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered. Fill piping 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Preliminary Work: Thoroughly clean pipe and tubing prior to installation. During installation, prevent foreign matter from entering systems. Prevent if possible or remove obstructions from piping and systems.

C. Flushing, Purging, Pressure and Flow Testing:

1. All fusion joints and loops lengths shall be checked to verify that no leaks have occurred in shipping or in fusion joining.
2. All loops shall be pressure tested before installation, and all horizontal components of the ground heat exchanger shall be pressure tested prior to back-filling.
3. Heat exchangers shall be tested hydrostatically at the smaller of 150% of the pipe design rating or 300% of the new system operating pressure. Do not test until every joint has set and cooled at least 8 hours. Maintain test pressure for 24 hours. Record trench temperature at start and finish of pressure test. There shall be no reduction in applied test pressure other than that due to a change in ambient temperature. Use test gage with one psi increment and readable to 1" psi.
4. Cleaning: Flush systems and apparatus, upon completion of pressure and miscellaneous test. Completely open valves and flush each system with clean water, prior to chemical cleaning. Repeatedly flush at short intervals until twice the system water capacity has been flush through. Chemically clean systems immediately following flushing operations. Circulate a solution consisting of trisoldium phosphate, in a proportion of one pound of chemical to every 50 gallons of water in the system. Completely fill system with cleaning solution; vent system and place in operation, with automatic controls operating and valves fully open. Allow system to reach design operating temperature. Circulate the solution through the system for a minimum of 4 consecutive hours; immediately drain and verify that flushing fluid

matches clean water input. Keep strainers unplugged during cleaning operations. Remove and clean strainer screens prior to operational test. Refill system with clean water.

5. Flow rates and pressure drops shall be compared to calculate values to assure that there is not blockage or kinking of any pipe.
6. A minimum velocity of 2 ft/sec in each piping section must be maintained for a minimum of 15 minutes to remove all air. A change of more than one inch in the level of fluid in the purge pumps tank during pressurization indicates air is still trapped in the system.

D. Prepare reports of testing activities.

E. Balancing: Balance pipe loop flow to quantities indicated on drawings.

F. Follow Code required stormwater, sediment, and erosion control requirements.

3.7 IDENTIFICATION

A. Install continuous underground detectable warning tape for underground piping. Locate below finished grade, 24 inches above the piping.

B. Detectable Warning Tape: Acid-and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:

1. Blue: Geothermal Heat Pump Water systems.

C. Submit record drawings. Utilize global positioning system device to locate all lines and vertical U-tubes. Update the record drawings daily. Demonstrate GPS coordinates of GPS device matches locations of pipes and U-tubes prior to final backfill and grading.

3.8 RESTORATION OF EXISTING LAWN

A. Restore, re-grade, and re-seed all lawns disturbed by the installation of the geothermal piping.

B. Remove from the site all soils unsuitable for backfilling.

C. See Division 23 Sections regarding grading and seeding.

D. Remove from the site drilling fluids. Do not discharge drilling fluids into streams, lakes, rivers, or ponds.

END OF SECTION

DIVISION 23 SECTION 233000
HVAC AIR DISTRIBUTION
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SECTION 233000 - HVAC AIR DISTRIBUTION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2 SUMMARY

A. For *General Mechanical Requirements*, see Division 23 Section, "Common Work Results for HVAC" and Division 01, "General Requirements".

B. The fabrication and installation of all ductwork, together with related equipment, shall comply with the standards of the National Fire Protection Association, as set forth in NFPA Standard No. 90A, as well as with the requirements of the Sheet Metal and Air Conditioning Contractors' National Association, Inc., and the latest edition of the ASHRAE Guide.

C. All duct sizes shown are net inside clear dimensions. Where internal duct lining is used, increase duct sizes accordingly to provide the indicated net free area. Unless otherwise indicated size runouts, drops, and connections to grilles, registers, diffusers, fans, coils, louvers, filters, and other equipment to the full size of the equipment connection.

D. Minor changes may be made in duct sizes where required to fit the available space, provided the indicated net free area and approximate aspect ratio are maintained.

E. Smoothly transition all ductwork to prevent excessive or unnecessary turbulence or pressure loss.

F. All exposed ductwork in finished areas shall be painted in color as indicated by Architect.

All ductwork requiring paint shall be constructed of paint grade galvanized sheet steel with a paintable finish.

1.3 REFERENCES

A. ASTM A 36 - Structural Steel.

B. ASTM A 90 - Weight of coating on Zinc-Coated (Galvanized) Iron or Steel Articles.

C. ASTM A 167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.

D. ASTM A 366 - Steel, Sheet, Carbon, Cold Rolled, Commercial Quality.

E. ASTM A 480 - General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.

F. ASTM A 525 - General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.

G. ASTM A 527 - Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process, Lock Forming Quality.

H. ASTM A 568 - Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled.

I. ASTM A 569 - Steel, Carbon (0.15 Maximum, Percent), Hot-Rolled Sheet and Strip, Commercial Quality.

J. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.

K. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

L. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.

M. SMACNA - HVAC Air Duct Leakage Test Manual.

N. UL 181 - Factory-Made Air Ducts and Connectors.

O. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

P. NFPA 70 - National Electrical Code.

Q. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.

1.4 PERFORMANCE REQUIREMENTS

A. No variation of duct configuration or sizes permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE Table of Equivalent Rectangular and Round Ducts.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the projects specified in this section with minimum five (5) years documented experience.

B. Installer: Company specializing in performing the work of this section with minimum five (5) years experience.

1.6 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA- 90A, and NFPA-90B.

1.7 ENVIRONMENTAL REQUIREMENTS

A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturer.

B. Maintain temperatures during and after installation of duct sealants.

1.8 ALTERNATES

A. Refer to Division 01, Section - Alternates for description of work under this section affected by alternates.

PART 2 PRODUCTS

2.1 DUCTWORK

A. Unless otherwise indicated or specified, fabricate ductwork of galvanized sheet steel, stainless steel, or aluminum conforming to Commercial Designation 3003 Temper H14 and Duct Sheet. Duct gages, jointing and reinforcement shall conform to Tables 4, 5, 6 and 7, as applicable, Chapter I of the latest *ASHRAE Guide and Data Book*. Construction details shall conform to Section I and Section II, as applicable, of *Duct Manual and Sheet Metal Construction for Ventilation and Air Conditioning Systems* as published by Sheet Metal and Air Conditioning Contractors' Association, Inc.

B. Erect sheet metal ductwork in a first-class, workmanlike manner secured in place rigidly and permanently. Provide suitable hangers, securely attached to building construction with bolts, clips or inserts. Hangers shall be structural shapes, flat bars, or formed strap

hangers; use of wire will not be permitted. Hangers shall not pass through or be inside duct. Support vertical ducts passing through floors by angles riveted to duct and resting either on floor or on brackets secured to building construction. All space around ducts where they pass through any walls, floors, ceilings, or roofs shall be sealed tight with incombustible inert material. Do not arrange ducts so as to impair the effectiveness of fireproofing around structural members. Provide sheet metal flanged collars around exposed ducts passing through walls, floors, or ceilings to provide finished appearance. Seal all duct joints and seams including supply, return, outside air, combustion air, relief air, ventilation air and exhaust ductwork with *Hardcast* Sealing System as manufactured by Hardcast, Inc., or approved equal.

C. Flexible connections of neoprene or other NFPA approved non-inflammable fabric shall be provided in the duct system at all fan inlet and outlet connections.

D. Provide cut turning vanes in all duct turns where centerline radius is located. Turning vanes shall be air-foil type with extended trailing edges. Fabricate to comply with SMACNA Sheet Metal Construction for Ventilation and Air Conditioning Systems Manual.

E. Provide duct collars and angle iron framework for mounting of automatic dampers.

F. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

G. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows are used, provide air foil turning vanes. Where acoustical lining is indicated, provide turning vanes of perforated metal with glass fiber insulation.

H. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.

I. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4-inch (100 mm) cemented slip joint, brazed or electric welded. Prime coat welded joints.

J. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.

K. Fasteners: Rivets, bolts, or sheet metal screws.

L. Hanger Rods: ASTM A36 - Galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.2 DUCT SYSTEMS

A. All supply, return, exhaust, fresh air intake, relief, ventilation, outside air ductwork shall be constructed for low pressure service (2 inch W.G.). All exposed round ductwork in finished areas shall be paintable grade, dual wall, constructed for medium pressure service (6 inch W.G.).

2.3 DUCT CONSTRUCTION

A. Rectangular and/or Round Ductwork (Low Pressure):

1. Galvanized Steel Ducts: ASTM A525 and ASTM A527 galvanized steel sheet, lock-forming quality, having G-90 Zinc coating in conformance with ASTM A90.
2. Make allowance for internal duct lining where required. Sizes shown on the drawings are inside clear dimensions.
3. Determine duct gauges for the longest duct side and use for all four sides. Joints and reinforcing requirements apply to the longest duct side.
4. Reinforce all ducts to prevent buckling, vibration, or noise as recommended in the referenced construction standards, and as required to suit the installed conditions.
5. Do not cross break duct which will receive rigid insulation covering.
6. Where tap sizes of divided-flow fittings are not indicated, make branch and main/connection sizes proportional to their respective air flows and maintain uniform transverse velocities in the fitting.
7. Make radius elbows and radius tee connection with throat radius equal to or greater than the width of the duct. Use vaned elbows where shown and where radius elbows will not fit the space, and in all square bends.
8. Turning vanes shall be the air-foil type with extended trailing edges, 36-inch maximum vane length. Where longer vanes are required, use two or more sets of vanes with intermediate runners securely fastened together.
9. Bolt, screw, rivet, or spot weld reinforcing members securely to the duct on not less than 6-inch centers.
10. Where ducts are open-ended without grilles, registers, or other means of stiffening, reinforce and stiffen the open end with standing seams or an angle frame. Provide rolled edges to prevent any exposed sharp edges.
11. Paint all cut ends on galvanized angles, rods, and other uncoated surfaces with aluminum paint.
12. Where ductwork is not painted or otherwise finished, remove all exposed traces of joint sealers, manufacturer's identification and other markings.
13. Aluminum sheet shall be 3003 H14 alloy or duct sheet, 16,000 psi minimum tensile strength, and capable of being formed to a Pittsburgh lock seam.
14. Reinforcing members for aluminum ductwork shall be galvanized steel or aluminum unless otherwise indicated. Where aluminum reinforcing is used, size the member in accordance with ASHRAE recommendations to have rigidity equivalent to listed mild steel angle sizes.
15. Where aluminum ductwork is used, make allowance for increased thermal expansion. Particularly avoid direct contact between aluminum and concrete or masonry walls subject to dampness.
16. Determine duct gauges per SMACNA based on duct size and pressure indicated.

B. Round and/or Rectangular Ductwork (Stainless Steel Type 316):

1. Stainless steel ducts: ASTM A167, Type 316.
2. All stainless steel ducts shall be round longitudinal seam or rectangular stainless steel Type 316. Determine duct gauges suitable for duct diameter and welded joints.
3. All longitudinal seams shall be installed with seam up.
4. These exhaust systems are low pressure service.
5. All elbows are round. Ninety degree squared elbows are not permitted.
6. All joints are welded by gas fusion using rods of similar materials.
7. All dampers, manual and motorized, shall be stainless steel Type 304.
8. These exhaust systems shall be fabricated and installed in strict accordance with requirements of SMACNA and NFPA.

C. Round Ductwork (Dual Wall - Medium Pressure)

1. Medium pressure flat oval and round ductwork shall be spiral lock-seam Type K-27 with Type P liner as manufactured by United Sheet Metal Company, Inc., Semco Manufacturing, Inc., Lindab, Ductmate, or approved equal, Uniseal duct and Uniform fittings. Construct ductwork of galvanized sheet steel. Elbows 8 inches in diameter and smaller shall be smooth formed. Larger elbows shall be five section type. Tees and crosses and laterals shall be conical. Make joints with sleeve type couplings, short length sheet metal screws and duct sealant. Seal joints with Hardcast, or approved equal, as hereinbefore specified. Conform to duct manufacturer's recommendations for jointing and installation. Ductwork and fittings shall be manufactured by a company regularly engaged in the construction of spiral ductwork and fittings. Contractor-fabricated ductwork will not be acceptable for ductwork and fittings. Manufacturers substituted for the above specified manufacturers shall submit for approval independently published laboratory test data on all proposed ductwork and fittings showing materials of construction, air flow, pressure drop and acoustical performance characteristics.
2. Round dual wall ductwork shall be installed to the extent shown on the drawings. All duct lining shall be provided with a perforated galvanized liner on the surface exposed to the air stream. All exposed ductwork in finished areas and where indicated on contract drawings shall be painted in color as selected by Architect. All ductwork requiring paint shall be constructed of paint grade sheet steel with paintable finish.
3. Round dual wall ductwork shall contain a 1 ½ inch thick fiberglass insulation sandwiched between inner and outer ducts.

2.4 CHEMICAL STORAGE CABINET DUCTWORK:

A. Stainless steel ductwork: ASTM A167, Type 316.

B. PVC ductwork: Schedule 40 PVC pipe with solvent joint fittings.

C. The ductwork serving chemical storage cabinets shall be Schedule 40 PVC pipe with

solvent joint fittings or 316 stainless steel with liquid tight welds.

2.5 AIR TRANSFER OPENINGS

A. Furnish and install metal sleeves or frames, of the same material as the duct or air terminals attached thereto, in all air transfer openings through walls, partitions, floors and other building construction, extending completely through the opening. Securely fasten the sleeves or frames in place and provide face flanges on both sides. Where grilles or registers are required, attach them to the sleeve or frame, or extend ductwork where shown on the drawings. If no grilles, registers or duct connections are required, furnish and install ½ inch x ½ inch removable galvanized wire mesh on one face.

2.6 AIR VOLUME CONTROLS

A. Furnish and install air volume control devices where indicated and where required to adjust and balance air flow in the systems, whether indicated or not. Volume dampers shall be provided in all branch ducts serving air outlets and inlets.

B. Air extraction for air outlets and branch ducts shall be the gang-operated vane type, Tuttle & Bailey - *Vectrol*, Type VLC or VLK as appropriate, or approved equal, with suitable adjusting device and means of access.

C. Manual volume dampers in ductwork shall be factory-assembled units with rigid frame, opposed-blade action, and locking quadrant operator. Mark the extended damper shaft and align the operating handle to indicate the blade position. Dampers shall be as manufactured by Ruskin, American Warming and Ventilating, Inc., Arrow, or approved equal. Rectangular dampers shall be Type MD35, with steel channel frame, 16 gauge steel blades, 9 inch maximum blade spacing, low pressure, nylon bearings, galvanized finish with aluminum paint touch up. Round manual balancing dampers shall be Type MDRS25 manufactured by Ruskin, Arrow, American Warming and Ventilating, Inc., or as approved equal. When external insulation is to be applied, provide sheet metal standoffs on all manual volume dampers. At contractors option shop made volume dampers with same performance characteristics may be utilized.

D. Motor-operated dampers shall be as hereinafter specified under Division 23 Section, “Instrumentation and Controls of HVAC & Plumbing System”.

E. Duct turning vanes shall be Tuttle & Bailey *Ducturns,* or approved equal.

F. Furnish and install duct collars and angle iron frames for the installation of ATC dampers.

G. Provide Type 316 stainless steel motor-operated dampers for installation in stainless steel ductwork.

H. Where volume dampers are installed in exposed finished spaces locate damper handle on top of duct.

2.7 INSTRUMENT TEST PORTS

A. Furnish and install instrument test ports in the ductwork to allow use of pitot tube length. Equip holes with Ventlok #699 instrument ports. Fittings shall extend beyond duct covering and insulation.

2.8 DUCT THERMOMETERS

A. Duct thermometers shall be Dresser Industries, Trerice, Weiss, Weksler, Miljoco, or approved equal direct-mounting filled system dial thermometers. Duct thermometers shall be vapor-actuated, universal-angle dial type, cast aluminum case with 4 ½ inch diameter, glass lens. Duct thermometers shall include adjustable joint with finish to match case, 180 degree adjustment in vertical plane, 360 degree adjustment in horizontal place, with locking device. Thermal bulbs shall be copper with phosphor-bronze bourden pressure tube. Movement shall be brass, precision geared. Duct thermometer scales shall be Progressive, satin-faced non-reflective aluminum with permanently etched markings. Each stem shall be copper-plated aluminum or brass for separable socket of length to suit installation.

B. Where ductwork is installed at a height that would require duct thermometers to be installed 10 feet above finished floor or greater then remote-ready filled - system dial thermometers shall be installed. Connecting tubing shall be bronze, double-braided, armor-over-copper capillary; of length to suite installation.

C. Duct thermometers shall be furnished and installed at energy recovery ventilators as follows:

LOCATION	RANGE
Outdoor Air Duct (Supply/Intake)	-40 degrees Fahrenheit to 120 degrees Fahrenheit
Exhaust Air Duct and Supply Air Duct	30 degrees Fahrenheit to 180 degrees Fahrenheit

D. Description: Flanged-fitting bracket for mounting in hole of duct, with threaded end for attaching thermometer.

1. Extension-Neck Length: Nominal thickness of 2 inches, but not less than thickness of exterior insulation.
2. Insertion-Neck Length: Nominal thickness of 2 inches, but not less than thickness of insulation lining.

2.9 DUCT ACCESS DOORS

A. Furnish and install adequately sized duct access doors at fire dampers, smoke dampers,

air measuring devices, motor-operated dampers, duct smoke detectors, duct coils and other locations where indicated and required for duct access. Doors shall be the continuous piano-hinged type with approved latches and neoprene compression-type gaskets with 1 inch thick fiberglass double skin and shall be Ruskin Model ADH22, Air Balance, Inc., FSA-100 or as approved equal. Stiffen ductwork at door openings. Where doors are installed in insulated ductwork, provide equivalent insulation in the door assembly. Where access doors are installed in the fire-rated partitions, provide *Fire Seal* access doors as manufactured by Air Balance, Inc., or approved equal, UL approved, meeting the rating of the enclosure in which the access door is installed.

B. Where duct access doors are installed in medium pressure ductwork, they shall be as manufactured by Ruskin, Type ADHP-3, or approved equal, with six latches continuous gasket and insulated core.

C. For walk-in plenums, provide insulated walk-through access doors, Ruskin Type ADW2, American Air Balance Type WA-100, or as approved equal.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

2.10 SPIN-IN FITTINGS

A. Furnish and install spin-in fittings where indicated on the contract drawings, Model SM-20G, as manufactured by General Environment Corporation, or an approved equal.

2.11 DUCT LINING (LOW PRESSURE DUCTWORK)

A. All low pressure supply and return ductwork within 10 feet of energy recovery ventilation units, and as additionally shown on Contract Drawings, shall be lined on the interior for sound attenuation and thermal insulation.

B. All internal duct lining for low pressure duct systems shall be provided with an interior galvanized perforated liner.

C. Provide additional exterior insulation where required and as indicated in Division 23 Section, “HVAC Insulation”.

D. The lining insulation shall be 1 inch thick, 3.0 pcf density, Aeroflex plus Duct Liner Type 300, Manville, Knauf, or approved equal. The material shall be specifically designed for this application, shall have a black, fire-resistant coating, shall meet NFPA Standards 90A and 90B and shall have a UL Fire Hazard Classification of Flame Spread 25 or less and smoke developed of 10 or less. The black-coated surface shall face the air stream.

E. All exposed edges and the leading edge of all cross joints of the liner shall be coated with the same adhesive used to secure the duct liner to metal surface.

F. The duct liner shall be adhered to the metal with 100 percent coverage of adhesive. Adhesive shall conform to Adhesive and Sealant Council Standards for adhesives for

duct liner; ASC-A-7001-A-1971.

G. The duct liner shall be additionally secured with mechanical fasteners, which shall compress the duct liner sufficiently to hold it firmly in place. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1-1971, available from Sheet Metal and Air Conditioning Contractors National Association.

H. All duct lining shall be installed in complete accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Liner Application Standard, First Edition.

I. Dimensions on drawings indicate inside clear opening of rectangular ductwork. Increase duct dimensions 2 inches each way for accommodating insulation on all shop or field-fabricated rectangular ductwork where lining is specified.

2.12 DUCT LINING (MEDIUM PRESSURE DUCTWORK)

A. All medium pressure supply and return ductwork within 10 feet of energy recovery ventilators, geothermal heat pumps, and as additional shown on contract drawings shall be lined on the interior for sound attenuation and thermal insulation.

B. Provide additional exterior insulation where required and as indicated in Division 23 Section, “HVAC Insulation”.

C. All internal duct lining for medium pressure duct systems shall be provided with interior galvanized perforated liner.

D. The insulation shall be 1 inch thick, 3.0 pcf density, Aeroflex plus Duct Liner Type 300, Manville, Knauf, or approved equal. The material shall be specifically designed for this application, shall have a black, fire-resistant coating, shall meet NFPA Standards 90A and 90B and shall have a UL Fire Hazard Classification of Flame Spread 25 or less and smoke developed of 10 or less. The black-coated surface shall face the air stream.

E. All exposed edges and the leading edge of all cross joints of the liner shall be coated with the same adhesive used to secure the duct liner to metal surface.

F. The duct liner shall be adhered to the metal with 100 percent coverage of adhesive. Adhesive shall conform to Adhesive and Sealant Council Standards for adhesives for duct liner; ASC-A-7001-A-1971.

G. The duct liner shall be additionally secured with mechanical fasteners which shall compress the duct lines sufficiently to hold it firmly in place. Mechanical fasteners shall conform to Mechanical Fastener Standard MF-1-1971, available from Sheet Metal and Air Conditioning Contractors National Association.

H. All duct lining shall be installed in complete accordance with the Sheet Metal and Air Conditioning Contractors National Association (SMACNA) Duct Liner Application Standard, First Edition.

I. Dimensions on drawings indicate inside clear opening of rectangular ductwork. Increase duct dimensions 2 inches each way for accommodating insulation on all shop or field-fabricated rectangular ductwork where lining is specified.

2.13 AIR TERMINAL DEVICES

A. Furnish and install air supply, return, exhaust devices of sizes and capacities as scheduled on the drawings. Catalog numbers shown are Metalaire, Inc., products for equipment which have been found suitable for the application. Products of Tuttle & Bailey, Anemostat, Division of Hart & Cooley, Carnes, Titus, Price, or approved equal will be considered only if performance characteristics including throw, drop, pressure loss, sound pressure level, etc., are equal to or better than the performance characteristics of the specified products. All air devices shall be ADC certified. Ductwork behind registers, grilles and diffusers shall be given two coats of flat black paint. Perimeter of all ceiling diffusers shall be caulked to provide a neat, aesthetic appearance.

B. Device Schedule:

AIR DEVICE SCHEDULE

Device	**Accessories**	**Finish**
Supply Diffusers, Lay-in Tile		
Model 5000-A, Rectangular MetalAire Ceiling Diffuser, Throw as Indicated	Integral opposed blade damper	White baked enamel finish
	Removable core	
	Louvered face	
	All aluminum construction	
	Auxiliary panel for lay-in tile installation	
	Adjustable pattern deflector	
Supply Diffuser, Gypboard, Surface Mount		
MetalAire Model 5000-A, Rectangular Ceiling Diffuser, Throw as Indicated (Surface or Duct Mount)	Integral opposed blade damper	White baked enamel finish
	Louver face	
	All aluminum construction	
	Removable core	

AIR DEVICE SCHEDULE		
	Adjustable pattern deflector	
Supply Register, Sidewall		
MetalAire Model V4004D, Sidewall Supply Register, Throw as Indicated (Surface or Duct Mount)	Integral opposed blade damper	White baked enamel finish
	All aluminum construction	
	22½ inch deflection blades	
	Double deflection spread & drop control	
Return/Exhaust, Transfer Register, Gypboard, Surface Mount		
MetalAire, Model RHD Rectangular Registers (Surface Mount)	Integral opposed blade damper	Off-white baked enamel finish
	45 degree angled deflecting vanes	
	All aluminum construction	
Return/Exhaust, Transfer Register, Lay-in Tile		
MetalAire, Model RHD Rectangular Registers	Integral opposed blade damper	Off-white baked enamel finish
	45 degree angled deflecting vanes	
	All aluminum construction	
	Auxiliary panel for lay-in tile installation	

C. Where air terminal devices are installed in duct collars or branches, furnish and install air extractors. Furnish and install control grids, volume dampers, and/or other accessories necessary to ensure uniform air flow across the terminal devices. Accessories shall be of the same material as the terminal device. Install fixed blade terminals so that blades block the normal line of vision. Furnish three (3) of each type of removable key operators.

D. Contractor shall determine frame and mounting type as per type of ceiling as shown on Architectural drawings.

2.14 OPEN END DUCTS (OED)

A. Whether indicated on plans or not, all open-ended ducts shall be provided with a protective screen.

B. All open-ended ducts shall be furnished with a 12 gauge ½ inch x ½ inch aluminum mesh screen. Screens shall be permanently installed in a removable frame, and the frame shall be attached to the open-ended duct in a neat, workmanship-like manner without any exposed edges or sharp surfaces.

C. Screen shall be attached to a ¾ inch x 1/8 inch continuous galvanized perimeter frame. Install duct stiffeners greater than 16 inches in any direction at open-ended ducts.

2.15 DRIP PANS

A. Furnish and install suitable watertight, aluminum drip pans where water or drain piping is routed over electrical switchgear, transformers, computers, etc. Each drip pan shall have a 1 inch copper type *M* drain piped to discharge where shown on drawings; or, if not shown, to discharge over nearest available open drain. Size and arrangement shall be as approved by Engineer. Sides shall be minimum 1.5 inches deep.

B. Drain pans shall be of 16 gauge welded construction. Provide drawings of typical drain pan construction for approval before construction. See Submittals in Division 01 Section, "Product Requirements".

2.16 DUCT SEALANTS AND ADHESIVES

A. All ductwork shall be sealed, including low pressure exhaust systems. Transverse joints and longitudinal seams in duct systems shall be sealed with a duct sealant of the type specified hereinafter in Section 1, 2, or 3, or with a tape sealing system as specified in Section 4. Spiral lockseams are not longitudinal seams and do not require duct sealant. All seams and joints shall require duct sealant suitable for the pressure rating and installation application. All sealants shall exceed 500 hours without becoming brittle under ASTM-D572 test conditions (oxygen bomb), unless specified otherwise. No surface preparation or solvent cleaning shall be necessary to remove light coatings of oil and dust before applying sealant unless specified otherwise. Flanged joints shall be sealed according to Section 5. Construction joints that are not fully welded shall be sealed according to Section 6. Adhesive to secure insulation to metal surfaces shall be that specified in Section 7.

1. Assembly joints to be installed indoors shall be sealed with United Duct Sealer or equivalent, which is a solvent-based (polymeric rubber) sealant formulated to withstand temperatures from –29 degrees F to +150 degrees F. Sealant shall have a UL Classification marking with a flame spread of 15 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 31 square feet per gallon. Sealant shall exceed 750 hours without becoming brittle under ASTM-D572 test conditions (oxygen bomb).
2. Assembly joints to be installed indoors and outdoors shall be sealed with UNI-WEATHER™ duct sealer or equivalent, which is a solvent-based (Neoprene-

phenolic mastic) sealant formulated to withstand temperatures from -20 to +300 degrees Fahrenheit. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 5 and smoke developed of 5 when applied to inorganic reinforced cement board, both at a coverage of 53 square feet per gallon. Sealant shall exceed 1,000 hours under ASTM-D572 test conditions (oxygen bomb) without becoming brittle and 500 hours in QUV accelerated-exterior-aging apparatus without degradation (under ASTM-C732 test conditions).

3. Assembly joints to be installed indoors shall be sealed with UNI-GRIP™ duct sealer or equivalent, which is a water-based (vinyl-acrylic polymer) sealant formulated to withstand temperatures from –25 degrees to +200 degrees Fahrenheit. Surfaces to be sealed should be clean, dry, and free from oil, grease, and dirt. Sealant shall be nonflammable (wet) and fire retardant. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 40 square feet per gallon.
4. Assembly joints shall be sealed with UNI-CAST® tape sealing system or equivalent, which is a combination of an adhesive activator and woven-fiber tape impregnated with a gypsum mineral compound. Modified acrylic/silicone activator (MTA-20 for indoor use) reacts exothermically with the tape to form a hard, airtight seal. Sealant shall be formulated to withstand temperatures from –40 degrees F to +200 degrees Fahrenheit. Combination of tape and MTA-20 adhesive shall have a flame spread and smoke developed of 0. Do not use for outdoors.
5. Flanged joints to be installed indoors shall be sealed with UNI-GASKET™ flange sealer or equivalent, which has a synthetic elastomer base and is formulated to withstand temperatures from –20 degrees F to +150 degrees F. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 5 when applied to inorganic reinforced cement board, both at a coverage of 80 square feet per gallon.
6. Where duct fittings are constructed with standing seam or spot-welded techniques, all construction joints shall be sealed with UNI-WELD™ metal cement or equivalent, which is composed of neoprene rubber, resins, and inert reinforcing material dispersed in a petroleum distillate. Sealant shall be formulated to withstand temperatures from –20 degrees F to +225 degrees F. Sealant shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, tested as applied in two 1/8 inch beads 8 inches on center.
7. Where insulation is to be secured to metal surfaces, the adhesive used shall be UNI-TACK™ duct liner adhesive or equivalent, which is a water-based, vinyl-acrylic copolymer formulated to withstand temperatures from –20 degrees Fahrenheit to +160 degrees Fahrenheit. Adhesive shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at a coverage of 267 square feet per gallon.

B. Manufacturers: Duct Mate, United McGill, Semco, Elgen, Childers, Benjamin Foster, or as approved equal.

PART 3 EXECUTION

3.1 DUCT INSTALLATION REQUIREMENTS

A. Coordinate ductwork with other work and install ducts at proper elevations and locations to maintain indicated ceiling heights and clearances. Provide all elbows, transitions, offsets, connections, and other fittings necessary to fit the work into place or to connect to equipment or diffusers. Method of duct support connection to structure and slabs shall be approved by Structural Engineer, and Shop Drawings shall be submitted.

B. Substantially support ductwork with structural shapes, flat bars, or formed strap hangers securely attached to the building structure by means of bolts, clamps, or inserts. Support vertical ducts by angles attached to the duct and resting on the floor or supported by brackets or hangers attached to the building structure. Strap hangers shall be 16-gauge minimum galvanized steel formed under the bottom edge of duct. Use square ¼ inch thick washers tight against the bend on upper strap attachments to horizontal surfaces. Place all supports external to the ductwork and out of the air stream. Provide additional supports at coils and other concentrated loads. Arrange supports so that duct weight is not transmitted to ceilings, fans or other equipment.

C. Prevent direct contact between ductwork and building surfaces or other equipment. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material. Provide flanged duct escutcheons at all exposed ducts that pass through walls, partitions, floors, and ceilings.

D. Use galvanized (compatible) corrosion-resistant hangers, supports, brackets, and hardware.

E. Furnish and install NFPA-approved duct connections where shown and at all connections to fans, air handling units, and similar rotating equipment. Use glass-reinforced neoprene fabric, roll-formed to sheet metal strips or flanges. Support adjacent ductwork to provide sufficient slack in the connection.

F. See NFPA 90A, and latest publication of SMACNA. Prevent direct contact between ductwork and building surfaces or other equipment. The opening in the construction around the duct shall not exceed one-inch average clearance on all sides. Where ducts pass through walls, partitions, floors, ceilings, or roofs, pack and seal the space around the duct with an approved fire-safe inert material capable of preventing the passage of flame and hot gases sufficiently to ignite cotton waste when subjected to the same NFPA 251 Time-Temperature Conditions required for fire barrier penetration. All exposed duct penetrations shall be finished with a sheet metal field erected flange escutcheon to form a neat appearance.

G. Coordinate duct installation with the requirements of Division 23 Section, "Vibration Controls for HVAC, Plumbing & Fire Protection Equipment".

H. Install in accordance with manufacturer's instructions.

I. Install and seal ducts in accordance with SMACNA *HVAC Duct Construction Standards - Metal and Flexible.*

J. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

K. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.

L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

M. Use crimp joints, with or without bead, for joining round duct sizes eight (8) inches and smaller with crimp in direction of air flow.

N. Use double nuts and lock washers on threaded rod supports.

O. Set plenum doors 6 to 12 inches (150 to 300 mm) above floor. Arrange door swings so that fan static pressure holds door in closed position.

P. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork systems.

3.2 ACCESSORY INSTALLATION REQUIREMENTS

A. Install accessories in accordance with manufacturer's instruction, NFPA 90A, and SMACNA HVAC Duct Construction Standards - Metal and Flexible.

B. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, duct detectors, air flow monitoring stations, duct-mounted equipment, and elsewhere as indicated. Review locations prior to fabrication.

C. Provide duct test holes where required for testing and balancing purposes. Review locations with Test and Balance Engineer prior to installation.

D. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment and supported by vibration isolators. Refer to Division 23 Section, "Vibration Control for HVAC and Plumbing Systems".

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum duct widths from duct take-off.

F. Use splitter dampers only where indicated.

G. Provide balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.

H. Install diffusers, registers, and grilles to ductwork with airtight construction.

I. Check location of all air outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangements.

J. Install duct thermometer support flanges in wall of duct. Attach to duct with screws. Locate duct mounted thermometers, minimum 10 feet downstream of mixing dampers, coils or other devices causing air turbulence.

K. Install remote - reading duct dial thermometers in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length. Mount control panel 60 inches above finished floor and label each dial thermometer.

L. Install duct accessories according to applicable details shown in SMACNA's *HVAC Duct Construction Standards--Metal and Flexible* for metal ducts.

M. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.

N. Provide test holes at fan inlet and outlet and elsewhere as indicated.

O. Adjust duct accessories for proper settings.

3.3 DUCT LINING INSTALLATION REQUIREMENTS

A. All portions of duct designated to receive duct liner shall be completely covered with duct liner. Transverse joints shall be neatly butted and there shall be no interruptions or gaps. The black pigmented or mat faced surface of the duct liner shall face the airstream.

B. Duct liner shall be adhered to the sheet metal. with 90 percent coverage of adhesive complying with requirements of ASTM C916. All exposed leading edges and transverse joints shall be factory coated or coated with adhesive during fabrication. Install perforated galvanized inner liner where indicated

C. Duct liner shall be additionally secured with mechanical fasteners, either weld-secured or impact-driven, which shall compress the duct liner sufficiently to hold it firmly in place. Adhesive bonded pins are not permitted due to long term adhesive aging characteristics. Spacing of mechanical fasteners with respect to duct liner interior width shall be in accordance with SMACNA HVAC DGS. Maximum spacing for mechanical fasteners shall be as follows:

Velocity = 0 to 2,500 feet per minute (0 to 12.8m/s):
From transverse end of liner 3: (75mm)

Across width of duct	12 inches (300 mm) O.C.
From corners of duct	4 inches (100mm)
Along length of duct	18 inches (450mm) O.C.

Velocity = 2,501 to 5,000 feet per minute (12.8 to 25.4 m/s):

From transverse end of liner	3 inches (75m)
Across width of duct	6 inches (150mm) O.C.
From corners of duct	4 inches (100mm)
Along length of duct	16 inches (400mm) O.C.

D. When air velocities exceed 4,000 fpm (20.3m/s), galvanized sheet metal nosing shall be applied to all leading edges of duct liner.

E. Acoustical Duct Liner shall be cut to assure overlapping and compressed longitudinal corner joints.

F. Upon completion of installation of duct liner and before operation is to commence, visually inspect the system and verify that the duct liner insulation has been correctly installed.

G. Open all system dampers and turn on fans to blow all scraps and other loose pieces of material out of the duct system. Allow for a means of removal of such material.

H. Check the duct system to ensure that there are no air leaks through joints.

3.4 CLEANING

A. Clean duct system and force air at high velocity through ducts to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with temporary filters, or bypass during cleaning.

B. Clean duct systems with high power vacuum machines. Protect equipment which may be harmed by excessive dirt with filters, or bypass during cleaning. Provide adequate access into ductwork for cleaning purposes.

C. Ductwork shall be cleaned in accordance with “Duct Cleanliness for New Construction (SMACNA 2000)”, and shall achieve a “Basic” cleanliness level.

3.5 LEAKAGE TESTS

A. All low pressure sheet metal ductwork shall undergo leakage tests at 3 inch W.G. Tests shall be accomplished under this section and witnessed as specified under Division 23 Section, “Testing, Adjusting, and Balancing for HVAC and Plumbing”.

B. All medium pressure sheet metal ductwork shall undergo leakage tests at 5 inch W.G. Tests shall be accomplished under this section and witnessed as specified under Division 23 Section, “Testing, Adjusting, and Balancing for HVAC and Plumbing”.

C. Leakage from each duct system shall not exceed 5 percent for low pressure systems and 1 percent for medium pressure systems of the normal air handling capacity of the system. If the system ductwork is tested in sections, the leakage shall not exceed ½ of 1 percent of the CFM to be handled by that section, and the total leakage of the system shall not exceed 1 percent of the total system CFM. Test pressure shall not exceed the pressure limits of the duct construction as defined in SMACNA *High Pressure Duct Construction Standards*. Repair all leaks which are audible, regardless of the leakage rate of the duct system as a whole, by remaking the entire defective joint or seam. Spot sealing of ducts in place *will not* be acceptable.

D. All duct accessories, including volume dampers, ATC equipment, and duct detectors shall be installed prior to duct leakage testing.

E. Submit a complete report of the ductwork leakage tests to the Architect and include final approved copies in test and balance reports.

3.6 DUCTWORK IDENTIFICATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. All ductwork shall be identified with painted background marked with the name of the service with arrows to indicate flow direction. Color Code and System Identification shall comply with ANSI Standards.

C. Marking shall be plain block letters, stenciled on ductwork (above and below ceilings) and shall be located near each branch connection and at least every ten feet on straight runs of ductwork. Where ductwork is aligned adjacent to each other, markings shall be neatly lined up. All markings shall be located in such a manner as to be easily legible from the floor.

D. Identify ductwork with plastic nameplates or stenciled painting. Identify with air handling unit identification and area served.

E. Length of color field for ductwork shall be 32 inches. Lettering shall be minimum 3-1/2 inches high.

END OF SECTION

DIVISION 23
SECTION 238125
VARIABLE REFRIGERANT VOLUME SPLIT SYSTEMS WITH HEAT RECOVERY (WATER COOLED SYSTEMS)
TABLE OF CONTENTS

SECTION238125 - VARIABLE REFRIGERANT VOLUME SPLIT SYSTEMS WITH HEAT RECOVERY (WATER COOLED SYSTEMS)

PART 1 GENERAL

1.1. RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Sustainable Design Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2. SUMMARY

A. This Section includes Variable Refrigerant Volume Split Systems with Heat Recovery.

B. Related Sections include the following:

1. Division 23 Section *HVAC Piping, Fittings and Valves* for refrigerant piping materials.
2. Division 23 Section *HVAC Insulation* for refrigerant pipe insulation requirements.
3. Division 23 Section, *Vibration Controls for HVAC, Plumbing, & Fire Protection Equipment* for isolation materials.
4. Division 23 Section, *Instrumentation & Controls of HVAC & Plumbing Systems* for temperature control devices, and control wiring and control devices connected to indoor, outdoor and refrigerant distribution devices.
5. Division 26 Section, *Disconnect Switches & Circuit Breakers* and circuit breakers for field installed disconnect switches.

1.3. DEFINITIONS

A. *EER*: Cooling full load energy efficiency ratio.

B. *IEER*: Cooling integrated (part load) energy efficiency ratio.

C. *High Temperature COP*: Heating coefficient of performance at 42°F.

D. *Low Temperature COP*: Heating coefficient of performance at 17°F.

E. *SCHE*: Simultaneous cooling and heating efficiency.

1.4. SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions.

B. Product data for Variable Refrigerant Volume units specified, including the following:

1. Dimension and plans and elevation drawings including field piping, required clearances and locations of all field connections.
2. Certified fan-sound power ratings.
3. Certified coil-performance rating with system operating conditions indicated.
4. Motor ratings and electrical characteristics plus motor and fan accessories.
5. Filters with performance characteristics.
6. Water cooled heat pump unit.
7. Summary of all auxiliary utility requirements such as electricity, refrigerant piping, Summary shall indicate quality and quantity of each required utility.
8. Branch selector box data.
9. Refnet data.
10. AHRI 1230 Certification including EER, IEER, High temperature COP, Low temperature COP, and SCHE.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Field Test Reports: Indicate results of manufacturer's startup and testing requirements. Submit copies of checklists.

E. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 01.

F. Warranties: Special warranties specified in this Section.

G. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR4.2): For products having recycled content, required documentations for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured,

assembled or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5. SYSTEM DESCRIPTION

A. Furnish and install where indicated, a variable capacity, heat recovery air conditioning system. System shall be a Variable Refrigerant Volume Series split system as manufactured by Daikin, Mitsubishi, LG, or approved equal. The system shall consist of multiple indoor units capable of cooling or heating, branch selector boxes, refrigerant joints to separate refrigerant flow between units and headers (refnets), a three pipe refrigeration distribution system using PID control, and water cooled unit. The indoor units shall be connected to the water cooled units utilizing the specialized piping joints provided by the equipment manufacturer.The water cooled unit is a direct expansion (DX), water-cooled heat recovery, multi-zone air-conditioning system with fixed speed and variable speed inverter driven compressors using R-410A refrigerant. The water cooled unit may connect to a connected indoor capacity up to 130% of the water cooled unit capacity. All zones are each capable of operating separately with individual temperature control. A dedicated hot gas pipe shall be provided to provide optimum heating operation performance.

B. Operation of the system shall permit either individual cooling or heating of each indoor unit simultaneously or all of the indoor units associated with one branch cool/heat selector box. Each indoor unit or group of indoor units shall be able to provide set temperature independently via a BMS interface. Provide all interlock wiring between system controllers and building automation system.

C. Branch cool/heat selector boxes shall be located as shown on the drawing. The branch selector boxes shall have the capacity to control cooling and heating downstream of the box. The box shall consist of electronic expansion valves, refrigerant control piping and electronics to facilitate communications between the branch selector box and main processor and between the branch selector box and indoor units. The branch selector box shall control the operational mode of the subordinate indoor units. The use of electronic expansion valves ensures continuous heating during defrost, no heating impact during changeover and reduced sound levels.

D. Manufacturer shall have five years prior experience making similar equipment as described in this specification.

1.6. QUALITY ASSURANCE

A. All equipment and systems shall be tested and certified in accordance with AHRI 1230 (Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air Conditioning and Heat Pump Equipment) and bear the AHRI certification seal.

B. Fabricate and label refrigeration system to comply with ASHRAE 15, *Safety Code for*

Mechanical Refrigeration.

C. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms *Listed and Labeled*: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

D. Comply with NFPA 70 for components and installation.

E. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

F. The system shall be factory tested for safety and function.

G. Coordination: Coordinate layout and installation of indoor units, water cooled units, refrigerant piping, branch selector boxes, refnets, and other appurtenances with piping and ductwork and with other installations.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver indoor and water cooled units as factory assembled units with protective crating and covering.

B. Coordinate delivery of units in sufficient time to allow movement into building or on to roof as indicated.

1.8. WARRANTY

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

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period: Compressors and Compressor Motor Contactors: Manufacturers standard, but not less than 6 years after date of Substantial Completion.

PART 2. PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Daikin, Mitsubishi, LG, or approved equal.

B. Basis of Design was a Daikin 3-pipe system. All scheduled capacities and efficiencies must be met. Cost of any electrical, piping, design, insulation, or other changes associated with other approved manufacturers shall be included in the bid and shall be the responsibility of the Contractor.

2.2. WATER COOLED UNITS

A. The water cooled unit is designed specifically for use with variable refrigerant volume system components. The water-cooled unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the heat pump unit shall consist of water cooled scroll compressors, motors, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports, refrigerant regulator, water cooled heat exchanger, and all components for a complete functioning system.

B. The water cooled unit shall be modular in design and should allow for side-by-side installation with minimum spacing.

C. The following safety devices shall be included on the water cooled unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor motors, over current protection for the inverter and anti-recycling timers.

D. Unit Cabinet: The water cooled unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

E. Condenser Coil: The condenser coil shall be manufactured from cupronickel.

F. Compressor: Unit shall contain both fixed speed scroll and inverter scroll compressors. Inverter scroll compressors shall be variable speed (PAM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the water-cooled unit. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read and calculated. Each non-inverter compressor shall also be of the hermetically sealed scroll type. With each reading, the compressor capacity (INV frequency or STD ON/OFF) shall be controlled to eliminate deviation from target value. Compressors shall be spring mounted to avoid the transmission of vibration.

2.3. BRANCH SELECTOR BOX

A. Branch selector (BS) boxes shall be located as shown on the drawing. The BS box shall be furnished with 5 electronic expansion valves (EEV's), refrigerant control piping and electronics to facilitate communications between the BS box and main processor and between the BS box and indoor units. The BS box shall control the operational mode of the subordinate indoor units. The use of five EEV's shall control the direction of refrigerant flow and ensure continuous heating during defrost, no heating impact during changeover and reduced sound levels. The branch selector boxes shall be designed specifically for use with heat recovery system components. These selector boxes shall be factory assembled, wired, and piped and shall be run tested at the factory. Unit Cabinet shall have a galvanized steel plate casing. Each cabinet shall house a liquid gas separator and contain a tube in tube heat exchanger. The unit shall have sound absorption thermal insulation material made of flame and heat resistant foamed polyethylene. Each circuit shall have at least one branch selector box to facilitate simultaneous heating and cooling in the system. Multiple indoor units may be connected to a branch selector box provided they are within the capacity range of the branch selector. The unit electrical power shall be as scheduled on the Contract Drawings.

2.4. INDOOR UNITS

A. Wall Mounted Indoor Unit - The unit shall be completely factory assembled and wired. The casing shall have a white finish. The evaporator fan shall be a high performance, forward curve line flow fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on permanently lubricated bearings. A manually adjustable change vane shall be provided. The vane shall have the ability to direct the air from horizontal to vertical. An adjustable guide vane shall be provided to manually change the air direction from lift to right. The evaporator coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan with drain shall be provided under the coil. Manufacturer shall furnish condensate lift pumps for field installation within the indoor unit. Condensate pumps shall be complete with float switch sensor, alarm, reed switch, relay, contact, adapters, and detection block etc., for a completely operational system. Contractor shall mount, pipe, and wire condensate pump per split system heat pump manufacturer's recommendations.

The unit electrical power requirements shall be as scheduled on the contract drawings.

B. Ceiling Cassette Indoor Unit - The unit shall be completely factory assembled and wired. The casing shall be galvanized sheet with grey heat insulation. This unit shall fit in the ceiling and have the capability of attaching a branch supply duct as well as a fresh air duct. The evaporator fan shall be an assembly with a high performance, fan direct driven by a single motor. The fans shall be statically and dynamically balanced and run on permanently lubricated bearings. The indoor unit shall have an adjustable air outlet system offering 4-way air flow, 3-way air flow, or 2-way air flow. The auto air swing vanes shall automatically swing up and down for uniform air distribution. Return air shall be filtered by a long-life filter to provide approximately, 2500 hours of use in a normal office environment before cleaning. The indoor unit shall be covered with a flat panel which protrudes only 1 inch below the ceiling to provide a neat and clean installation. The coils shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tubes joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory. A condensate pan shall extend under the coil and piping. An integral drain pan pump capable of lifting condensate 22 inches shall be provided. An integral booster heater shall not be provided to supplement the unit during the heating mode. The unit electrical power requirements shall be as scheduled on the contract drawings.

2.5. CONTROL SYSTEM

A. The control system shall consist of multiple microprocessors interconnected by a single non-polar two wire multiplex transmission system. Wiring shall be daisy chained from unit to unit direct. NO SPLICES. One microprocessor shall be factory wired and located within each indoor unit. It shall have the capability of sensing return air temperature and indoor coil temperature; receive and process commands from the remote controller. The microprocessor within the wall mounted remote controller shall provide automatic cooling and heating system changeover; display set point and room temperature; a 24 hour on/off timer so that automatic operation can be set on the timer at one hour intervals from one to twenty-four hours; have self-diagnostic function display; check mode for memory of most recent problem; and provide on-off and system/mode function switching. The heating system shall be controlled so that only warm air is discharged whenever the fan speed exceeds the very low (VLO) speed. Normal operation of the remote controller provides individual system control in which one remote controller and one indoor unit are installed in the same room. The control voltage between the indoor units and the outdoor unit shall be 16 volts D.C. 16 VDC shall be generated from the outdoor unit microprocessor board. The system shall be capable of automatic restart when power is restored after power interruption. System shall include twenty function self diagnostics including total hours of compressor run time. Compressor capacity shall be modulated automatically to maintain a constant suction pressure, while varying the refrigerant volume for the needs of the cooling or heating loads. Indoor units shall use PID control to control superheat.

B. Provide interface devices as required to interface to Building Automation System. ATC

Interface shall allow monitoring of all points indicated on the point list.

C. Furnish the controls with the necessary interfaces to communicate via BACnet/IP or LonWorks to a building automation system. Exact protocol to be determined by the ATC Subcontractor.

D. All inputs and outputs on the manufacturer's controller shall be viewable via the interface.

E. All set points and schedules shall be editable via the interface by the building automation system.

F. In addition to standard inputs/outputs provide additional input/outputs as required to accomplish sequence of operation and items listed on point list.

G. The manufacturer shall be responsible for assisting and participating in the integration of the equipment into the building automation system and shall provide programming, testing, verification, and on site personnel as required.

PART 3. EXECUTION

3.1. EXAMINATION

A. Examine space for compliance with requirements for conditions affecting installation and performance of swimming pool dehumidification units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. INSTALLATION

A. Mount indoor and compressor units as detailed on contract drawings and according to manufacturer's written instructions.

B. Install all interlock and control wiring between indoor units, water-cooled units thermostats, and condensate pumps.

C. Supply initial charge of refrigerant and oil as required.

D. Install indoor ceiling cassette on vibration isolators.

E. Install compressor units on concrete pads as indicated on drawings.

F. Comb out fins on evaporator coils where deformed or bent. Replace or repair broken fins.

G. Install condensate lift pumps, float switches, alarm, unit shut down wiring and detection block units per manufacturer's recommendations.

H. For wall mounted units field wire power wiring, alarm circuits, control cable, safety circuit connection, alarm, and condensate pump. Condensate pump shall be powered from indoor unit power wiring. Coordinate condensate pump electrical characteristics with indoor unit electrical characteristics.

3.3. CONNECTIONS

A. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. High/low pressure gas line, liquid and suction lines must be individually insulated between the water cooled and indoor units.
2. Refrigerant Piping: conform to applicable requirements of Division 23 Section, *HVAC Piping, Fittings, and Valves*. Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.
3. Install refrigerant piping, refnets, Brande selector boxes, insulation, and control wiring as required by the manufacturer.
4. Install isolation valves on all three pipes between outdoor unit and branch selector boxes.
5. Install isolator valves on both pipes of all indoor units.

B. Electrical: Conform to applicable requirements in Division 26 Sections.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4. COMMISSIONING AND MANUFACTURER'S FIELD SERVICES

A. Verify that installation is as indicated and specified. Provide factory authorized start-up and training.

B. Complete manufacturer's installation and startup checks and perform the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, water-cooled condenser coil, and fans.
3. Verify that clearances have been provided for servicing.
4. Check that labels are clearly visible.
5. Clean water cooled heat exchanger inspect for construction debris.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Verify all piping and branch selector boxes are insulated.

10. Verify water flow.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Start-up units in close coordination with testing/balancing.

D. Check and record performance of interlocks and protection devices; verify sequences.

E. Operate unit for an initial period as recommended or required by manufacturer.

F. Calibrate thermostats and humidity sensors.

G. Check internal isolators.

H. Start refrigeration and measure and record the following:

1. Coil leaving-air, dry- and wet-bulb temperatures.
2. Coil entering-air, dry- and wet-bulb temperatures.
3. Refrigerant suction/discharge pressures.
4. Indoor and water cooled unit amperage, voltage, and watts.
5. Fan Rotation and RPM.

3.5. DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Review data in the maintenance manuals. Refer to Division 01 Section, *Contract Closeout*.
2. Review data in the maintenance manuals. Refer to Division 01 Section, *Operation and Maintenance Data.*
3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION

DIVISION 26
SECTION 260500
COMMON WORK RESULTS FOR ELECTRICAL
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SECTION 260500 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 ALTERNATES

A. Refer to Division 01 Section, "Alternates" for description of work under this Section affected by Alternates.

1.3 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Foam Duct Sealant.
5. Grout.
6. Plywood Backboards.
7. Common electrical installation requirements.

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, boxes, and conduit, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 26 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.

H. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all Contract Drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with Article "Submittals" as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

1.4 PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with Division 01 Section, *General Requirements*.

C. Notify Inspection Authorities to schedule inspections of work.

D. Notify Architect and Engineer in advance of scheduled inspections.

E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections.

1.5 EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.6 INTERPRETATION OF DOCUMENTS

A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder's part.

B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.

C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.

D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.

E. Where variances occur between the Drawings and Specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.

F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with Article "Submittals" as herein after specified. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer, and Owner.

H. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.

I. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.

J. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.

K. The complete set of Architectural, Civil, Structural, Mechanical, and Electrical Drawings and Specifications apply to this work. The successful Bidder shall familiarize himself with all other related documents.

1.7 MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.8 ELECTRICAL WORK UNDER OTHER DIVISIONS

A. Mechanical Equipment and Systems

1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.
2. Certain mechanical units are furnished from the factory with starters, contactors, transformers, fuses, wiring, etc., required for fans, pumps, etc. When this equipment is supplied from the factory, the Electrical Contractor must supply power circuit(s) to the unit and a disconnecting means. Coordinate with Mechanical Contractor so that one and only one, set of starters, fuses, switches, etc., is provided and installed.
3. In general, control and interlock equipment for HVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Division 23. Division 26 shall install and connect all such equipment as necessary.
4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided under Division 23. Division 26 shall install and connect all such equipment.

B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers,

contacts, etc. Provide power circuits and disconnects to such equipment and install all electrical control equipment related thereto.

C. Owner Furnished Equipment: In general, Owner furnished equipment is either provided or wired by the equipment supplier. Provide power circuits to such equipment and make final connections to equipment being provided by the Owner.

D. Carefully review the Contract Documents and coordinate the electrical work under the various Divisions.

1.9 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.10 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this Specification, latest edition:

1. ADA - Americans with Disabilities Act
2. ANSI - American National Standards Institute
3. ASTM - American Society for Testing and Materials
4. CSA - Canadian Standards Association
5. EPA - Environmental Protection Agency
6. FM - Factory Mutual
7. IBC - International Building Code
8. IEEE - Institute of Electrical and Electronics Engineers
9. NEC - National Electrical Code
10. NECA - National Electrical Contractors Association
11. NEMA - National Electrical Manufacturers Association
12. NFPA - National Fire Protection Association
13. OSHA - Occupational Safety and Health Act
14. UL - Underwriters' Laboratories

15. The application standards of the local electric utility company.

B. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.11 SUBMITTALS

A. Product Data: For items specified in Part 2 of this Section.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Specification 018113.

1.12 SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6) copies, or more as required under the General Conditions, of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.13 SHOP DRAWINGS

A. Prepare and submit Shop Drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.

B. Submit Product Data and Shop Drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable Specification paragraph number and Drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

Items and Systems

1. Analysis & Coordination Study
2. Arc Flash Hazard Analysis
3. Arc Flash Hazard Labels
4. Ballasts for Lighting Fixtures
5. Battery Packs for Lighting Fixtures
6. Conductors and Cables - 600V or Less
7. Conduit and Raceway
8. Disconnect (Safety) Switches - Fused/Non-Fused
9. Equipment Nameplates/Labels
10. Firestopping Materials
11. Foam Duct Sealant
12. Fuses, 600V or Less
13. Ground Conductors
14. Ground Rods
15. Grout
16. Hangers and Supports
17. Identification Products
18. Installation/Coordination Drawings of Electrical Room Layouts
19. Installation/Coordination Drawings of Mechanical Room Layouts
20. Installation/Coordination Drawings of Other Spaces as indicated in the Specifications
21. Junction and Pull Boxes, Standard Sizes
22. Lamps
23. Lighting Control Panels
24. Lighting Fixtures, Exterior

25. Lighting Fixtures, Interior
26. Lightning Protection System Wiring Diagrams
27. Lightning Protection System Product Data
28. Lightning Protection System Shop Drawings
29. Manholes and Manhole Accessories
30. Medium Voltage Cable Termination & Splice Kits
31. Medium Voltage Cables
32. Medium Voltage Grounding
33. Medium Voltage Switchgear
34. Motor Controllers
35. Motor Starters
36. Operation and Maintenance Manual
37. Outlet and Device Boxes
38. Panelboard Circuit Directories
39. Panelboards
40. Photocells
41. Receptacles
42. Record Drawings
43. Sleeve Seals
44. Sleeves
45. Solar Photovoltaic Conductors and Cables
46. Solar Photovoltaic Inverters
47. Solar Photovoltaic Modules
48. Solar Photovoltaic Monitoring System and Display
49. Solar Photovoltaic Mounting System
50. Solar Photovoltaic System Equipment Nameplates/Labels
51. Surge Protective Devices
52. Testing Agency Qualifications
53. Tests and Reports
54. Toggle/Snap Switches
55. Transformers, 600V and Less
56. Underground Ductbank Products

D. Submittals shall include but not be limited to the following information: size, type, functional characteristics, compliance with standards in Division 26, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Documents requirements.

E. Submit for approval any other shop drawings as required by the Engineer. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

F. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.

G. Prepare and submit a detailed schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.

1.14 DEFINITIONS

A. *Approve*: To permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

B. *Building Line*: Exterior wall of building.

C. *Concealed:* Hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or attic.

D. *Conduits* include conduit, all fittings, identification, and other accessories relative to such conduit.

E. *Contractor:* The electrical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

F. *EPDM*: Ethylene-propylene-diene terpolymer rubber

G. *Exposed:* Not installed underground or *concealed* as defined above.

H. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

I. *Furnish and install* or *provide*: To supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

J. *Location, Damp*: Locations protected from water and not subject to saturation with water or other liquids, but subject to moderate degrees of moisture. Examples of such locations include interior locations such as basements, crawlspaces, attics, cold-storage rooms, etc…

K. *Location, Dry*: A location not normally subject to dampness or wetness. A dry location may temporarily be subject to dampness or wetness during building construction.

L. *Location, Wet*: Locations subject to saturation with water or other liquids, locations exposed to weather, and installations underground or in concrete slabs or masonry in direct contact with the Earth. Examples of such locations include all exterior locations (including those under canopies, roofed open porches, etc…) commercial kitchens, and vehicle washing areas.

M. *NBR*: Acrylonitrile-butadiene rubber.

N. *Review*: Limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

1.15 LEED REQUIREMENTS

A. Refer to Division 01 Section, *LEED Requirements* for description of work under this Division affected by LEED requirements.

1.16 RECORD DRAWINGS

A. Upon completion of the electrical installations, the Contractor shall deliver to the Architect or Engineer one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering the same to the Architect.

1.17 WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the General Conditions.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.

2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.

3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

1.18 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six (6) copies of the Operations and Maintenance Manual and deliver these copies of the manual to the Owner. The manual shall be as specified herein. The manual must be approved and will not be accepted as final until so stamped.

B. The manual shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual – Delaware Technical and Community College Sustainable Energy Training Center - Electrical.* No sheets

larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the manual:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Complete catalog data on each piece of electrical equipment furnished including approved Shop Drawing/Submittal with Engineer's Comments (if any).
4. Manufacturer's extended limited warranties on equipment.
5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
6. Provide supplier and subcontractor's names, address, and phone number.
7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.
8. Access panel charts with index illustrating the location and purpose of access panels.
9. Approved Electrical Certificates.
10. Start-up reports for equipment.

D. Submit Operation and Maintenance Manual(s) prior to anticipated date of Substantial Completion for Engineer review and approval. Substantial Completion requires that Operation and Maintenance Manual(s) be reviewed and approved.

E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.

F. Deliver all instruction materials to the Owner prior to the formal instruction period.

G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.

H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

I. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.

J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

K. Where specified in technical sections, provide longer periods required for specialized equipment.

L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

M. The Operation and Maintenance Manual(s) shall be available at the time of the instructions, for use by Instructors and Owner personnel.

N. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

1.19 INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:

1. Mechanical Rooms indicating transformers, panelboards, enclosures, boxes, conduits, mechanical equipment, ductwork, and piping, etc…
2. Electrical Rooms indicating switchboards, panelboards, enclosures, boxes, transformers, conduits, wireways, etc…

B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout Drawings shall include, but not be limited to the following:

1. Pad-mounted equipment and equipment connections.
2. Underground conduits, ductbanks, and building penetrations.

D. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:

    a. Working space and dedicated space clearances per the NEC.
    b. Clearances for equipment disassembly required for periodic maintenance.
    c. Exterior wall and foundation penetrations.
    d. Fire-rated wall and floor penetrations.
    e. Equipment connections and support details.
    f. Sizes and locations of required concrete bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.

5. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, and Mechanical, to avoid possible demolition and installation conflicts.

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM, interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

2.4 FOAM DUCT SEALANT

A. Description: Two-part, high-expansion foam duct sealant to keep water, acids, dust, gases, insects and rodents out of ducts (conduits).

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. American Polywater Corporation

C. Basis of Design: FST Foam Sealant by American Polywater Corporation.

D. The foam duct sealant shall be a two-part "blown" urethane foam with 98% closed cell content.

E. The foam duct sealant shall have a compressive strength of 300 pounds (ASTM D1691), a ten sile strength of 250 pounds (ASTM D1623), and a flexural strength of 450 pounds (ASTM D790).

F. The foam duct sealant shall be compatible with common cable jacket materials. The cured foam shall be an inert solid that does not affect jacket materials.

G. The foam duct sealant shall withstand temperatures from -20 degrees Fahrenheit to 200 degrees Fahrenheit and shall not lose function in direct sunlight

H. The foam duct sealant shall be chemically resistant to gasoline, oils, dilute acids and bases, and most unsaturated hydrocarbons.

I. The foam duct sealant shall foam and react in five to ten minutes at 70 degrees Fahrenheit.

J. When installed, the sealant shall be capable of holding 7.25 psi air pressure continuously (equivalent of 16.4 feet water-head pressure).

2.5 PLYWOOD BACKBOARDS

A. 4’x8’x 3/4” thick AC grade or better fire-retardant plywood.

B. Backboards shall be painted with a minimum of two coats of flame retardant paint to match adjacent wall color.

2.6 FASTENERS

A. All fasteners located in public spaces including classrooms, corridors, lobbies, toilet rooms, etc…, shall be provided with tamper proof fasteners. Provide Pin Phillips hardware as manufactured by Challenge Industries or approved equal.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES:

A. General: Refer to the Division 01 Sections for general requirements of temporary facilities.

B. Description: Furnish and install the necessary metering and distribution equipment for an adequate, 3-phase, 4-wire temporary electrical service and all temporary wiring, including step-down or step-up dry-type transformers as required. Exact requirements for temporary service will be determined by the General Contractor.

C. Attention is directed to the Occupational Safety and Health Act (OSHA), Americans with Disabilities Act (ADA) and National Electrical Code (NEC) requirements for electrical work on construction sites.

D. Materials:

1. At least one light outlet per 900 square feet on each floor.
2. One 20-ampere circuit with ground fault protection for each 3000 square feet of gross floor area per floor to which various trades may attach their cords.
3. One temporary power line in each corridor including connections to saws, if required, with ground fault protection.
4. Power for crane operation if required.

E. Installation: Temporary lighting shall provide minimum foot candle levels for construction as follows:

AREA	FOOT CANDLE LEVEL
General construction area lighting, corridors, hallways and exit ways.	5
Electrical equipment rooms, active storerooms, shops, locker and dressing areas	10

F. The Contractor shall pay for all energy charges for temporary service.

G. Obtain and pay for temporary electrical service for construction power.

H. Provide temporary construction power.

I. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc., for obtaining power from utility company lines.

J. Remove all temporary power installations and connections after permanent power is established and/or prior to completion of the project.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Install equipment with working space and dedicated space in strict accordance with 2011 NEC Article 110.26.

E. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

F. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

G. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.

H. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.

I. Right of Way: Give to piping systems installed at a required slope.

J. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.

a. Do not install outlets, switches, etc., behind casework, cabinets, etc.
b. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
c. Coordinate counter top outlets with drilling of casework/counters.
d. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navi-

gation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

H. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements of Division 07 Section "Joint Sealants.".

I. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements of Division 26 Section "Electrical Firestopping".

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals. Seal interior of each raceway with Foam Duct Sealant as specified herein.

M. Cut sleeves to length for mounting flush with both surfaces of walls.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 26 Section "Electrical Firestopping".

3.7 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. Installing Equipment Foundations (Housekeeping Pads):

1. Provide four (4) inch high concrete foundations (housekeeping pads) for all floor-mounted equipment extending a minimum of 6 inches beyond equipment bases for interior equipment and a minimum of 12 inches beyond equipment bases for exterior equipment, unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement, chamfer exposed edges and corners, and finish exposed surfaces smooth.

2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.

3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.

4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

3.8 PROVISIONS FOR ACCESS

A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.9 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed, as defined herein.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect, unless otherwise directed by Architect/Owner.

H. All exposed conduit, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.10 COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

3.11 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.12 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section "Temporary Facilities and Controls".

D. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.13 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

E. Submit all test results to the Architect/Engineer for approval.

3.14 WALL AND FLOOR PENETRATIONS

A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 26 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 26.

B. All penetrations of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, “Electrical Firestopping”.

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide conduit escutcheons for all exposed conduit penetrations in finished interior spaces and all exposed exterior penetrations. Escutcheons shall match those provided under Division 23.

E. Conduit sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.15 EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of the equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.16 PHASING

A. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities Having Jurisdiction (AHJ).

B. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The Contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.17 OUTAGES

A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.

B. Submit *Outage Request Form*, attached at the end of this Section, to Owner for approval.

3.18 CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 26. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

3.19 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where conduits penetrate roofs, flash pipe with Stoneman *Stormtite,* Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install curbs, vent assemblies, and sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

3.20 CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 26. Perform work in accordance with requirements of Division 03 and other applicable Divisions of these Specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

D. Installing Outdoor Equipment Foundations:

1. Provide equipment foundations of size and thickness as indicated.
2. Place reinforcement accurately in position shown, securely fasten and support to prevent displacement before or during pouring. Clean, bend, place, and splice reinforcement in accordance with approved shop drawings. Lap ends and sides of mesh reinforcement in slabs not less than one inch. Coverage of main reinforcing shall be as follows:

    a. Slabs - 3/4 inch
    b. Concrete poured against earth - 3 inches
    c. Other locations - 2 inches
3. Properly align, level, and grout all equipment where necessary.

3.21 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the Drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped, such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 26 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 26, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition. Where existing insulation is disturbed, replace insulation where removed or damaged equal to existing, in type, thickness, density, finish and thermal resistance (R-value) value.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the Contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

3.22 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.
5. To provide working space and dedicated space clearances per 2011 NEC Article 110.26.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames".

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 26 Section "Electrical Firestopping".

3.23 EXCAVATION AND BACKFILLING

A. General:

1. Perform all necessary excavation, or installation of work under Division 26, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the Specifications)

1. Excavate only the required elevations. If excavation is carried below the founda-

tion lines or other required limits, backfill the excess with concrete.

2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, and OSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the Specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE:_____

END OUTAGE - TIME: _____ DATE:_____

AREAS AND ROOMS: _____

FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ____ NO ___ BY: _____DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ____ NO: ___ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

DIVISION 26
SECTION 260513
MEDIUM VOLTAGE CABLES
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SECTION 260513 - MEDIUM VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements" "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 GENERAL:

A. Definition: Medium voltage power cables shall mean all cables rated 5 kV and above.

B. Provide all necessary cables as indicated on the drawings or as specified herein.

C. This specification covers medium voltage conductor shielded power cable suitable for use in wet and dry locations in conduit, underground duct systems, direct-buried and aerial installations.

1.5 RATING

A. Fifteen (15) kV cable for use on 12.0 kV grounded system.

1.6 CODES AND STANDARDS:

A. All cables and accessories furnished under this Section shall be in accordance with the latest applicable standards of AEIC, ANSI, NEMA, IEEE, ICEA, OSHA, and the National Electrical Code. In addition, 15 KV cable and accessories shall be in accordance with the

requirements of local utility company. The requirements of the local utility are in addition to, and in no way a waiver of, the applicable codes and standards.

B. Where any requirements specified herein or shown on the Contract Drawings exceed the listed standards, the Bidder shall adhere to the higher standard. In the case of conflict in requirements between two or more standards, the decision of the Engineer shall be final. Code compliance is mandatory. Nothing in the Drawings and Specifications implies acceptance of work that does not comply with Codes.

C. Where applicable, all equipment and materials shall be listed and labeled by a nationally recognized testing laboratory with equipment listing and follow-up services.

1. American National Standards Institute (ANSI)

   a. ANSI C2 National Electrical Safety Code

2. National Electrical Manufacturers Association (NEMA)

   a. NEMA WC8 Ethylene-Propylene-Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

3. National Fire Protection Association (NFPA)

   a. NFPA 70-2008 National Electrical Code

4. American Society for Testing and Materials (ASTM):

   a. ASTM B-8 Concentric-Lay-Stranded Copper Conductors; Hard, Medium, or Soft.
   b. ASTM B-231 Concentric-Lay-Stranded Aluminum Alloy 1350 Conductors.

D. Association of Edison Illuminating companies (AEIC): AEIC CS6 EP Rubber Insulated Wire Cable.

E. Insulated Cable Engineers Association (ICEA): ICEA S-68-516 Cables Rated 0-3500X Ozone Resistance.

F. Underwriters Laboratories (UL): UL-1072 List of Acceptable Sunlight Resistant PVC Compounds for use as insulating and/or jacketing material on listed outdoor flexible cords.

G. AEIC CS 5-1987: Specifications for Thermoplastic and Crosslinked Polyethylene Insulated Shielded Power Cables Rated 5 through 35 kV.

H. AEIC CS 6-1987: Specification for Ethylene Propylene Rubber Insulated Shielded Power Cables Rated 5 through 69 kV.

I. IEEE 48-1990: Standard Test Procedures and Requirements for High-Voltage Air-Conditioning Cable Terminations (ANSI).

J. IEEE 386-1995: Standard for Separable Insulated Connectors System for Power Distribution Systems above 600 V (ANSI).

K. IEEE 404-1993: Standard for Cable Joints for Use with Extruded Dielectric Cable Rated 5000-138,000 Volts and Cable Joints for Use with Laminated Dielectric Cable Rated 2500-500,000 Volts (ANSI).

L. IEEE 576-1989: Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in the Petroleum and Chemical Industry (ANSI).

M. IEEE C2-1996: National Electrical Safety Code (ANSI).

N. ICEA T-31-610-1994: Guide for Conducting a Longitudinal Water Penetration Test for Sealed Conductor.

O. NETA ATS-1995: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

P. NEMA WC 7-88 (ICEA S-66-524): Cross-Linked-Thermosetting-Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

Q. NEMA WC 8-88 (ICEA S-68-516): Ethylene-Propylene-Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy.

R. NEMA WC 26-90 (including Revision 1 - 1993): Wire and Cable Packaging.

S. NFPA 70-2008: National Electrical Code.

1.7 GENERAL REQUIREMENTS

A. All materials supplied by the Contractor shall be new, of recent manufacture, and of the highest commercial grade as specified. They shall be resistant to moisture and corrosion to withstand their environment and operational conditions with minimum maintenance and long life.

1.8 QUALIFICATIONS

A. The manufacturer of the materials specified herein shall have at least ten years of demonstrated experience in the manufacture of the specified product.

B. The manufacturer shall be a company specializing in the manufacture of medium voltage cable and/or accessories with minimum five years documented experience in producing cable and/or accessories similar to those specified below.

C. The cable materials and manufacturer shall meet or exceed all applicable requirements of the latest editions of ICEA Standard S-68-516, AEIC and NEMA Standards.

D. The cable shall be manufactured using the triple tandem extrusion process in which all layers, from the conductor to, and including, the insulation tape shield, are installed at essentially the same time without an intervening storage period on reels or other storage devices.

E. Factory Tests:

1. Cable shall be factory-tested at high voltage AC, high voltage DC, and for corona discharge in accordance with ICEA requirements.
2. Certification of satisfactory completion of factory tests for cables shall be submitted to the Engineer at the time of cable delivery.

1.9 SUBMITTALS

A. Submit product data indicating cable and accessory construction, materials and ratings.

B. Submit Manufacturer's certificate stating factory test voltage.

C. Submit Manufacturer's installation instructions.

D. Submit Manufacturer's Certificate stating that medium voltage cable meets or exceeds all requirements.

E. Manufacturer's instructions for storage, handling, protection, examination and field testing of cables and accessories before initial energization.

F. Samples: 16-inch (400-mm) lengths of each type of cable specified.

G. Product Certificates: Signed by manufacturers of cables and accessories certifying that the products furnished comply with requirements.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

J. Product Test Reports: Indicate compliance of cables and accessories with requirements based on comprehensive testing of current products.

K. Medium Voltage Cable Terminating and Splicing Workman's Competency: In order to establish workman's competency regarding medium voltage cable terminating and splicing, the Contractor shall be required to submit the following within 30 days prior to commencement of termination of work.

1. Documentation to verify that the individual has completed a termination and splice of the types to be installed, under the supervision of the cable accessory manufacturer, or his representative.

2. Documentation that the dummy termination and splice have undergone and passed the following tests, to be performed by the splice kit supplier. These results shall be attached for review.

Test	Minimum Value
Discharge Ext. Value with 3 pc or less	13 kV
AC Withstand, 1 minute	35 kV
DC Withstand, 15 minutes	65 kV

3. A statement of the number of years in which the individual has been splicing/terminating medium voltage cables.
4. A list of the last three jobs where specific splices/terminations were installed within the last 12 consecutive months. This list shall include splice/termination manufacturer, catalog number, cable type and the quantity installed.

L. Maintenance Data: For cables and accessories to include in the maintenance manuals specified in Division 01.

1. Include periodic tests of cables in service.
2. Include operation of fault indicators, separable insulated connectors, and accessories.

M. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.10 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with IEEE C2 and NFPA 70.

1.11 PROJECT RECORD DOCUMENTS

A. Submit record documents under provisions of Division 01.

B. Accurately record exact sizes, lengths, types, quantities, and locations of cables. Indicate where all splices and terminations are located for each cable.

1.12 DELIVERY, STORAGE AND HANDLING

A. Deliver products to site under provisions of Division 01 and comply with NEMA WC 26.

B. Store and protect products under provisions of Division 01. Store cables and reels on elevated platforms in a dry location.

C. Accept cable and accessories on site in manufacturer's packages and inspect for damages.

D. Protect cable and accessories from weather by covering with opaque plastic or canvas. Provide ventilation to prevent condensation.

E. Cable shall be stored according to manufacturer's recommendations as a minimum. In addition, cable must be stored in a location protected from vandalism and weather. If cable is stored outside, it must be covered with opaque plastic or canvas with provision for ventilation to prevent condensation and for protection from weather. If air temperature at cable storage location will be below 40 degrees F, the cable shall be moved to a heated (50 degrees F minimum) location. If necessary, cable will be stored off site.

1.13 SITE REQUIREMENTS

A. Provide responsibility for all safety requirements on the work site.

B. Comply with OSHA Confined Space Regulations, 8CCR 5156-5158.

C. Barricade open utility holes and pullboxes at all times. Provide for safe flow of traffic and pedestrians.

D. Provide for continuous, mechanically supplied, fresh air to manholes and vaults where workers are inside.

E. All switching of existing circuits shall be performed. Verify that circuits are de-energized and locked out prior to starting work.

F. Scheduled outages that may be required to complete the work will be coordinated with the Owner.

G. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect/Engineer at least two (2) days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer/Architect's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer must be able to meet these Specifications as well as the latest edition of Association of Edison Illuminating Company (AEIC) Specification CS6 and other applicable industry standards and specifications.

B. The proposed 15 KV cable must be approved acceptable by local utility company.

C. 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. Cables:

a. Okonite Company (The).
b. Prysmian (formally Pirelli) Cable Corporation; Power Cable Division.
c. American Insulated Wire Corporation; Leviton Manufacturing Company.
d. BICC Brand-Rex Company.
e. Carol Cable Company, Inc.
f. Kerite Company (The); Hubbell, Inc.
g. Rome Cable Corporation.
h. Southwire Company.

2. Cable Splicing and Terminating Products and Accessories:

a. 3M Company; Electrical Products Division.
b. Elastimold.
c. Engineered Products Company.
d. G & W Electric Company.
e. Mac Products, Incorporated.
f. MP Husky Corporation.
g. Raychem Corporation; Energy Division.
h. RTE Components; Cooper Power Systems, Inc.
i. Scott Fetzer Company; Adalet-PLM Subsidiary.
j. Thomas & Betts Corporation.

2.2 MEDIUM VOLTAGE CABLE - SHIELDED

A. Usage: This cable shall be used for all above and underground applications (except for jumper cable applications. See "Jumper Cable" below) and shall be contained in conduit or other raceways. It may be used in cable trays in electrical vaults only.

B. Cable: Single conductor, insulated cable rated 15 kV, 133% insulation level, ungrounded, NEC-UL Type MV-90. Sizes as indicated on the Drawings.

C. Conductor: Soft copper, annealed, uncoated, Class B compressed or concentric stranded, having nominal direct-current resistance equal to or less than that required in Section 2.5.2 and Table 2-12 of ICEA S-68-516.

D. Conductor Shield: Copper tape, helically applied over extruded semiconductor with resistivity requirements of Section 2.4 of ICEA S-68-516. Material shall be clean stripping from the conductor and firmly bonded to the overlying insulation.

E. Insulation: Extruded EPR (ethylene propylene rubber), rated at 15 kV, 133 percent insulation level, minimum nominal thickness of 0.220 inches, minimum insulation K factor of 50,000 megohms per 1000 foot length. Manufacturer's Certification of this value shall be a part of submittal for cable approval.

F. Insulation Shield: the insulation shield shall consist of an extruded semiconducting layer directly over the insulation and a coated copper tape over the semiconducting covering. The tape shall be at least 2.5 mils (0.0635 mm) thick and be spiral wrapped with a 12.5 percent overlap. The insulation shield shall meet all requirements of ICEA Section 4.1.1.

G. Jacket: Black, Polyvinyl Chloride (PVC) or Chlorinated Polyethylene (CPE), all with a nominal jacket thickness – 80 mils (2.03 mm), meeting all requirement of ICEA.

H. Cable Rating: Continuous duty at 90 degrees C, wet or dry locations, suitable for underground duct installations, NEC-UL Type MV-90, Type USE.

2.3 GENERAL CABLE REQUIREMENTS:

A. Cable shall be single conductor shielded, NEC UL Type MV-90, Class B stranded bare copper, covered with an extruded layer of semi-conducting ethylene-propylene based elastomer (EPR).

B. The insulation shall be an ethylene-propylene elastomer which shall meet or exceed the electrical and physical characteristics of ICEA-S-68-516 and AEIC CS6 (latest edition). The insulation thickness shall be 115 mils for 5 KV, 220 mils for 15kV, and 345 mils for 35kV class service.

C. The insulating compound shall have a maximum ethylene content of 72% by weight and shall not contain any polyethylene.

D. The insulation screen shall be an extruded layer of semi-conducting ethylene-propylene based material with a volume resistivity not in excess of 10 ohm-meters (at 90 degrees C) and shall be applied in accordance with AEIC CS6.

E. Both inner and outer semi-conducting compounds shall have an elongation after air oven aging at 121 degrees C for 160 hours of 100 percent and a brittleness temperature not warmer than -50 degrees C. The semi-conducting layers and insulation shall be applied using the triple tandem extrusion process.

F. A 5 mil base copper tape shield shall be applied over the outer semi-conducting layer with a nominal 12.5 percent overlap.

G. The overall jacket shall be polyvinylchloride applied in accordance with ICEA S-68-516 Part

H. A permanent marking on the jacket shall indicate cable type, size, conductor type, and rated voltage.

2.4 TERMINATIONS

A. The selected termination system shall be approved by the cable manufacturer. Possible types of acceptable terminators include:

1. Cast Epoxy Cable Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including stress cone, shield ground connection, epoxy resin molding material, and accessories and molds necessary for proper application.
2. Modular Molded Rubber Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including stress cone, ground clamp, non-tracking rubber skirts, connector, rubber cap. Termination shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10% to 90% equipotential lines) over entire length of skirted insulator.
3. Tape Termination: IEEE 48; Class 1. Kit form, suitable for use with cable specified, including semi-conductive tape, stress control tape, splicing tape, vinyl plastic tape, stress cone, mechanical ground straps, and cable preparation kit.
4. Raychem Type HVT, heat shrinkable termination kits.

B. Lugs shall be copper, long barrel, two-hole or four-hole and rated for the voltage applied. The lugs shall match the pads on the equipment to which the cable will be mounted. For example, if the equipment has a four-hole pad, the cable lug shall be four-hole type.

C. If there will be more than one cable on an equipment pad, approved spiders (or spacers) must be used. Cable attachment to equipment must match the equipment manufacturers UL labeling requirements (if the equipment is UL listed) as a minimum. Unless the equipment is designed or listed for it, cable lugs may not be placed back-to-back on the equipment pad. In all cases, the termination and equipment must be taped with approved anti-tracking tape.

D. Modular Molded Shrink Type Splice; IEEE 404-1986; Class 1; 15 kV. Kit form, suitable for use with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute electric field (10 percent to 90 percent equipotential lines) over entire length of insulating material.

E. Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. This semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymer insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.

F. Splicing sleeves shall be long barrel type and rated for the voltage applied.

G. The completed splice shall be approved for underground direct burial and water immersion service.

2.5 SPLICE KITS

A. Connectors: IEEE 404, compression type, as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended in writing by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors and splices specified. Include all components required for complete splice, with detailed instructions.

1. Combination tape and cold-shrink rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
3. Premolded, cold-shrink rubber, in-line splicing kit.
4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

C. Modular Molded Shrink Type Splice; IEEE 404-1986; Class 1; 15 kV. Kit form, suitable for use with cable specified, including slip-on type flexible polymer or silicon rubber insulator. Splice shall be hot or cold shrink type with internal stress relief tube to distribute

electric field (10 percent to 90 percent equipotential lines) over entire length of insulating material.

D. Molded body shall contain a built-in internal semiconducting layer which covers and contacts the splice barrel and the cable insulation layer to prevent electrical stress buildup inside the body. This semiconducting layer shall be bonded to and covered with a cured EPDM rubber or polymer insulating layer which, in turn, shall be bonded to and covered with a semiconducting layer and metallic shield and jacket.

E. Splicing sleeves shall be long barrel type and rated for the voltage applied.

F. The completed splice shall be approved for underground direct burial and water immersion service.

2.6 SOLID TERMINATIONS

A. Multiconductor Cable Sheath Seals: Type recommended by Seal Manufacturer for type of cable and installation conditions, including orientation.

1. Compound-filled, cast-metal body, metal-clad cable tetminator for metal-clad cable with external plastic jacket.
2. Cold-shrink sheath seal kit with preformed sleeve openings sized for cable and insulated conductors.
3. Heat-shrink sheath seal kit with phase-and ground-conductor rejacketing tubes, cable-end sealing boot, and sealing plugs for unused ground-wire openings in boot.
4. Cast-epoxy-resin sheath seal kit with wrap-around mold and packaged, 2-part, epoxy-resin casting material.

B. Conductor Terminations: Comply with IEEE 48, as indicated. Insulation class is equivalent to that of cable. Terminations for shielded cables include a shield ground strap.

1. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
2. Class 1 Termination for Shielded Cable: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
3. Class 1 Termination for Shielded Cable: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
4. Class 1 Termination for Indoor Shielded Cable; Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
5. Class 2 Termination for Shielded Cable; Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connectors. Include silicone-rubber tape, cold-shrink rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.

6. Class 3 Termination for Shielded Cable: Kit with stress cone and compression-type connector.

2.7 SEPARABLE INSULATED CONNECTORS

A. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

B. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

2.8 ARC-PROOFING MATERIALS

A. Tape for First Course on Metal Objects: Ten-mil (250 micrometer) thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.

B. Arc-Proofing Tape: Fireproofing tape, flexible, conformable, intumescent to 0.3 inch (8 mm) thick, compatible with cable jacket.

C. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1/2 inch (13 mm) wide.

2.9 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 and ICEA S-94-649 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways to receive medium-voltage cables for compliance with requirements for installation tolerances and other conditions affecting performance of cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 CABLE PULLING

A. Prior to pulling cable, a mandrel/swab 1/4 inch smaller than the duct diameter shall be pulled through duct run to insure adequate opening of duct run. Thoroughly swab conduits to remove foreign material before pulling cables.

B. Cables shall not be pulled into outside (exterior) or underground systems from an outside (exterior) or underground location when the outside (exterior) air temperature is below 40 degrees Fahrenheit.

C. Furnish all required installation tools to facilitate cable pulling without damage to the cable jacket. Such equipment is to include, but not be limited to, sheaves, winches, cable reels and/or cable reel jacks, duct entrance funnels, pulling tension gauge, and similar devices. All equipment shall be of substantial construction to allow steady progress cone pulling has begun. Makeshift devices which may move or wear in a manner to pose a hazard to the cable shall not be used.

D. Cable ends shall be sealed and firmly held in the pulling device during the pulling operation.

E. Cable pulling shall be done in accordance with cable manufacturer's recommendations, except as modified herein, and ANSI/IEEE C2 standards. Manufacturer's recommendations shall be a part of the cable submittal. Recommended pulling tensions shall not be exceeded. Pulling bending radius shall not be less than that determined by the manufacturer of the NEC. Actual pulling tensions shall be continuously monitored and permanently recorded in a log and submitted to the Engineer at the end of the project. Restrictions of pulling bending radius dimensions shall be strictly observed. Training bending radius shall not be less than 12 times cable diameter. Any cable bent or kinked to radius less than recommended dimension shall not be installed.

F. During pulling operation, an adequate number of persons shall be present to allow cable observation at all points of duct entry and exit as well as to feed cable and operate pulling machinery.

G. Cable Pulling: Test existing duct lines with a mandrel and thoroughly swab out to remove foreign material before the pulling of cables. Pull cables down grade with the feed-in point at the manhole or buildings of the highest elevation. Use flexible cable feeds to convey cables through the manhole opening and into the duct runs. Cable slack shall be accumulated at each manhole or junction box where space permits by training the cable around the interior to form one complete loop. Minimum allowable bending radii shall be maintained in forming such loops.

H. Cable pulling tensions shall not exceed the maximum pulling tension recommended by the cable manufacturer.

I. Pulling lubricant shall be used to ease pulling tensions. Lubricant shall be of a type which is non-injurious to the cable material used. Lubricant shall not harden or become adhesive with age.

J. Lubricants for assisting in the pulling of jacketed cables shall be those specifically recommended by the cable manufacturer. Cable lubricants shall be petroleum grease for lead-covered cables (soap-stone, graphite, or talc for rubber jacketed cables). The lubricant shall not be deleterious to the cable sheath, jacket, or outer coverings.

K. Avoid abrasion and other damage to cables during installation.

L. Where cables are left in manhole or switchgear overnight or more than 8 hours prior to termination, the cable ends shall be sealed with paraffin or shrink wrap caps and supported in a manner which will prevent entrance of moisture into the cable. Cable shall be terminated and energized as soon as possible.

3.3 INSTALLATION

A. The firm shall be a company specializing in installation of medium voltage cable and accessories with a minimum of five years documented experience in installation of the type of cable and accessories described below.

B. The electricians employed for this work shall be experienced in medium voltage cable installation. Workmen involved in splicing and termination of cables shall have been specifically trained in the procedures required for the splices and terminations used in this project. At the discretion of the Engineer, documentation of experience and/or training in medium voltage cable splicing and termination shall be furnished. At the Engineer's discretion, the electricians making up terminations or splices shall make up a sample splice and/or termination to be used to determine the capability of the electrician(s) involved.

C. Install cables as indicated, according to manufacturer's written instructions and IEEE 576.

D. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Install direct-buried cables on leveled and tamped 3-inch (75-mm) bed of clean sand at bottom of trench. Separate cables crossing other cables or piping from those items by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "underground line" warning tape 12 inches (305 mm) above cables. Refer to Division 26 Section, “Electrical Identification” for additional requirements.

G. Install separable insulated-connector components where indicated according to manufacturer's written instructions. Provide the following quantities of components:

1. Protective Cap: Install at each Terminal Junction, one on each terminal to which no feeder is indicated to be connected.
2. Portable Feed-through Accessory: 3.
3. Standoff Insulator: 3.

3.4 CABLE ROUTING IN UTILITY HOLES AND EQUIPMENT

A. Certain utility holes, as indicated on the drawings, shall have the cable looped around the walls. In such cases, the cable shall circle the manhole at least 360 degrees. Where utility holes are not to be looped, cable shall be routed on the walls with the longest distance between points of entry and exit.

B. All new and existing cable in utility holes shall be secured to racks on the utility hole walls. Cables shall be secured to racks with split porcelain insulators and clamps. Insulator openings shall be of adequate size to contain all three phases and the ground of a given circuit. Fastening cables directly to support brackets with wire or plastic ties will not be accepted. Support cables at 4' intervals with galvanized steel racks and channels and porcelain insulators or non-metallic cable racks. Cable weight shall not rest on terminations.

C. Cables within switchgear shall be routed in a manner which will allow adequate room for bending and terminating cables. Cables must be secured in a manner which will not result in cable weight being placed on the termination electrical joint. Cable support shall be made in a manner that does not force cable against grounded metal or which compresses cable diameter. Cable training bending radius shall be at least 12 times cable diameter.

D. Jumper cable shall be routed in a manner that prevents it from contacting any metallic surface.

E. Installation of cables in utility holes, manholes: Do not install cables utilizing the shortest route, but route along those walls providing the longest route and the maximum spare cable lengths. Form all cables to closely parallel walls, not to interfere with duct entrances, and support on brackets and cable insulators at a maximum of 18 inches. In existing utility holes; handholes and vaults where new ducts are to be terminated or where new cables are to be installed, the existing installation of cables, cable supports and grounding as required for a neat and workmanlike installation with all cables properly arranged and supported. Support cable splices in underground structures by racks on each side of the splice. Locate splices to prevent cyclic bending in the spliced sheath. Install cables at middle and bottom of cable racks, leaving top space opening for future cables, except as otherwise indicated for existing installations. Provide one spare three-insulator rack arm for each cable rack in each underground structure. (Provide cable racks in each underground structure through which cable is run.)

F. Ground metallic non-current carrying components such as cable racks, switches, and transformers. Use a #6 solid copper conductor, minimum.

G. In utility holes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

3.5 TERMINATING AND SPLICING

A. Cable Terminating: Protect terminations of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of termination devices and materials. Install all terminations of insulated power and lighting cables in accordance with the manufacturer's requirements. Make terminations using materials and methods as indicated or specified herein or as designated by the written instructions of the cable manufacturer and termination kit manufacturer. Keep cable ends sealed prior to splicing or termination to prevent the entrance of moisture.

B. Splices in Medium Voltage Cables: Splices shall be suitable for continuous immersion in water and shall be made only in accessible locations in manholes or handholes. Clearly mark splices buried directly in earth by an identification slab.

C. Certification: Medium voltage cable splicer/terminator certification of competency and experience shall be submitted thirty (30) days before splices or terminations are made in high voltage cables. Splicer/termination experience during the immediate past three years shall include performance in splicing and terminating cables of the type and classification being provided under this contract.

D. Cast-Type Splice Methods: Cast-type splice insulation shall be provided by means of a molded casting process employing a thermosetting epoxy resin insulating material which shall be applied by a gravity-poured method or by a pressure-injected method. The component materials of the resin insulation shall be in a packaged form ready for convenient mixing without removing from the package. Do not allow the cables to be moved until after the splicing material has completely set.

E. Kit Methods: Medium voltage splices shall be made using kit which shall be the product of one Manufacturer and shall have the approval in writing of the manufacturer of the cable which is to be spliced. Provide the Contracting Officer Quality Control Representative with a copy of the Manufacturer's instructions before splicing is started. Splices shall be made only in utility holes and handholes.

F. Splices in Shielded Cables: Splices in shielded cables shall include covering the spliced area with metallic tape, or like material, to the original cable shield and by connecting it to the cable shield on each side of the splice. Provide a No. 6 AWG bare copper ground connection brought out in a watertight manner and grounded to a 3/4-inch by 10-foot ground rod as part of the splice installation. Wire shall be trained to the sides of the enclosure in a manner to avoid interference with the working area.

G. Splices are to be held to a minimum. Splice locations shall be determined by cable lengths available, pulling conditions and termination points. Splice locations are to be listed by the Contractor prior to cable purchase and a listing of such locations submitted to the Engineer for approval before final cable lengths are determined.

H. Only experienced electricians shall be employed in this phase of the work. Refer to *Quality Assurance* above.

I. Follow cable manufacturer's and splice or termination manufacturer's installation instructions and ANSI/IEEE C2 standards.

J. Clean, white lint-free gloves shall be used to handle the end of the cable during tape wrapping procedures.

K. Termination or splicing of the copper conductors (both power and ground conductors) shall be made only with tool-applied compression (swaged) fittings.

L. Ground system connections:

1. Cable to Bus: Compression cable fitting bolted to bus with lock washers under nut.
2. Cable to Ground Rod: Approved bolted fitting with backing plate between cable and rod.

M. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware according to manufacturer's written instructions.

N. Splice or termination failure upon high potential acceptance test will require complete reconstruction of the joint to Manufacturer's Specifications. Make sure that there is enough free cable at each termination or splice for two more terminations or splices to be performed.

O. Install Scotch #70 tape for anti-tracking on all exposed terminations.

P. All splices and terminations are to be tagged using embossed plastic tags with plastic attachment devices indicating date splice or termination was made, name of electrician involved, name of Contractor installing cable, feeder number and circuit to and from data.

Q. All cable splices in manholes shall be supported on both sides of the splice within 2'-0" of the splice. Splices shall not rely on cable for support.

R. Lugs shall be bolted to termination pads in equipment using corrosion-resistant bolts, nuts, and washers. Use Belleville washers for bolting aluminum to aluminum, and lock washers for bolting copper to copper or as recommended by equipment manufacturer. Washers shall be in the lug side. Torque to Manufacturer's recommendations.

S. Install splices at pull points and elsewhere as indicated. Use standard kits. Comply with kit manufacturer's written instructions.

T. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits. Comply with kit manufacturer's written instructions and with classes of terminations indicated.

3.6 FIRE-PROOFING AND ARC PROOFING

A. Fireproofing (Arc Proofing) of Cables in Utility Holes, and Handholes: All wire and cables which will carry current at 2200 volts or more in manholes, and handholes shall be fire-proofed.

B. Exposed cables in utility holes shall be fireproofed. Entire installation shall conform to Manufacturer's recommendations.

C. Arc proofing material shall be Scotch #77 electrical arc and fireproofing tape, or approved equal.

D. Install the fireproofing on the cables as follows:

1. Install tightly applied fireproofing tape, approximately 1/16-inch thick by 1-1/2 inches wide minimum, around each feeder spirally on one-half-lapped wrapping.
2. Install the tape with the coated side towards the cable and extend it not less than one inch into each duct.
3. Install random wrappings of Scotch #69 glass cloth tape around the installed fire-proofing tape per Manufacturer's instructions to prevent it from unraveling.

E. Fireproofing Tape: Strips of fireproofing tape approximately 1/16-inch thick by 3 inches wide shall be wrapped tightly around each cable spirally in half-lapped wrapping, or in two butt-joined wrappings with the second wrapping covering the joints in the first. The tape shall be applied with the coated side toward the cable and shall extend one-inch into the ducts. To prevent unraveling, the fireproofing tape shall be random wrapped the entire length of the fireproofing with pressure sensitive glass cloth tape. The fireproofing tape shall consist of a flexible, conformable fabric having one side coated with flame retardant flexible, polymeric fabric having one side coated with flame retardant, flexible, polymeric coating and/or a chlorinated elastomer not less than 0.050 inch thick and shall weigh not less than 2.5 pounds per square yard. The tape shall be noncorrosive to cable sheath, shall be self-extinguishing, and shall not support combustion. The tape shall not deteriorate when subjected to oil, water, gases, salt water, sewage and fungus.

F. Arc Proofing: Arc-proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials, unless otherwise indicated. Apply as follows and as recommended by manufacturer of arc-proofing tape:

1. Clean cable sheath.
2. Wrap metallic cable components with 10-mil (250-micron) pipe-wrapping tape.
3. Smooth surface contours with electrical insulation putty.
4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
5. Band arc-proofing tape with 1-inch-(25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

3.7 PHASING

A. Verify by *hot phase* test that cables on loop and tie circuits are matched phase-to-phase at every splice or termination that occurs at an open point. Use an approved live-line phasing meter and follow safety and switching procedures. This test may only be performed by personnel experienced in and qualified for testing of energized circuits. Do not rely on color markings for assurance of proper phasing.

B. Verify correct phase rotation when cables on radial circuits are replaced. Use approved secondary voltage rotation tests or verify that the rotation of existing motors is correct.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing.

B. Testing:

1. On installation of medium-voltage cables and before medium voltage cables have been terminated and spliced, demonstrate product capability and compliance with requirements.

   a. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.2.
   b. Certify compliance with test parameters.

2. Upon splicing of medium voltage cable to existing and before energizing, perform insulation test.

   a. Provided documentation spliced medium voltage cable adhered to all insulation test requirements.

C. Correct malfunctioning cables and accessories at project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Test and inspect cables according to NEMA WC 7 (ICEA S-66-524) and NEMA WC8 (ICEA S-68-516) before shipping.

E. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

F. Tests shall be performed on completed cable in accordance with ICEA S-68-516 and AEIC CS6 (latest edition) as specified.

1.	Conductor Resistance	per AEIC Paragraph 1.2
2.	AC Withstand (5 minutes)	5 kV - 22 kV 15 kV - 44 kV
3.	IR Constant (at 15.6 C), min.	50,000 megohms - 1000 feet
4.	DC Withstand (15 min.)	5 kV - 45 kV 15 kV - 80 kV
5.	Partial Discharge	Per AEIC, 5 pc max. at 4 times rated voltage

G. Test Reports: Certified test reports shall be furnished for all cables.

H. Field inspection and testing will be performed under provisions of Division 01.

I. Inspect exposed cable sections for physical damage. Verify that cable is connected according to Drawings and that shield grounding, cable support, and terminations are properly installed.

J. Perform DC high potential test of each conductor, with other conductors grounded, in accordance with the manufacturer's recommendations. Apply test voltage to conductors in at least eight equal increments to maximum test voltage. Record leakage current at each increment, allowing for charging current decay. Hold maximum test voltage for ten minutes.

K. Record results of test in tabular form and in plots of current versus voltage for incremental voltage steps, and current versus time (30 second intervals) at maximum voltage. Curves shall be identified with the cable to which they apply and shall be certified. Time of day, outside temperature and humidity at time of each test shall appear on each curve sheet.

L. Perform shield continuity tests.

M. Perform phasing checks.

N. If any primary cable fails, or tests, in the opinion of the Owner, unacceptable cable defects, all cables in that conduit between the nearest pulling points on each side of the failure shall be removed. If, in the opinion of the Owner, other cables that may have been installed in the same duct are not damaged, they may be re-installed, but the failed cable shall be replaced with new cable without additional charge.

O. After replacement of the faulty cable, and any other damaged cables, all cables of the circuit in that conduit shall be re-tested. If the cable fails again, or if tests, in the opinion of the Architect, show unacceptable cable defects, all cables shall be replaced without charge and this procedure shall be repeated until tests prove satisfactory.

3.9 CABLE IDENTIFICATION AND LABELING

A. Provide the following information on cable identification label:

1. Main feeder circuit breaker number.
2. Phase.
3. To and From Data.

B. Install cable labels on each conductor at each cable termination, each cable splice, in each manhole and in each pullbox. Additionally, at these locations, provide on inch (1") colored vinyl plastic electrical tape wrap identification, (Scotch 35 or approved equal) around each conductor and cable as follows:

1. 15 kV individual conductor system:

   a. A - Phase - one (1) red wrap.
   b. B - Phase - two (2) red wraps with ½-inch space between wraps.
   c. C - Phase - three (3) red wraps with ½-inch space between wraps.

2. 15 kV multi-conductor cable system - three (3) red wraps with no space between wraps.

C. See paragraph above under "Terminating and Splicing" for splice label requirements. This is in addition to identification labels.

D. During entire cable installation, phasing of conductors shall be maintained and identified. Where final connections to equipment are made, phasing shall be verified and proper phase rotation determined prior to connection.

E. Identify cables as to manufacturer, year, voltage, size, temperature, rating and ampere capacity. If such identification is not visible on the surface, the information shall be supplied on an engraved lamicoid tag permanently secured to the cable in each accessible location.

F. Identify cables with circuit number and last and next accessible location at each substructure with an engraved lamicoid nameplate.

G. Cables shall be identified in every manhole and pullbox by voltage, circuit name, and location of next accessible point. Identification tags shall be stamped lead or engraved lamicoid nameplate, red with white letters, approximately three-inch by five-inch (3-inch x 5-inch), fastened with #12 copper wire.

3.10 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer, to prevent entrance of moisture into the cables and to ensure medium-voltage cables are without damage or deterioration at the time of Substantial Completion.

END OF SECTION

DIVISION 26
SECTION 260519
CONDUCTORS AND CABLES
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SECTION 260519 - 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements" "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

A. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Indicate procedures and values obtained.

B. Submit Product Data: Provide for each cable assembly type, wire, cables, conductors, and connectors.

C. Submit factory test reports. Indicate procedures and values obtained.

D. Submit manufacturer's installation instructions. Indicate application conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements.

E. Project Record Documents: Record actual locations of components and circuits.

F. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 01 Section *Quality Control*, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full-member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.

1. The Terms *Listed and Labeled*: As defined in NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

C. Comply with NEMA/Insulated Cable Engineers Association (ICEA) Standards.

D. Comply with NECA Standard of Installation.

E. Comply with NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

F. American Society for Testing and Materials (ASTM): Comply with requirements of the following:

1. B1: Standard Specification for Hard-Drawn Copper Wire
2. B2: Standard Specification for Medium-Hard-Drawn Copper Wire
3. B3: Standard Specification for Soft or Annealed Copper Wire
4. B8: Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
5. D753: Standard Specification for General Purpose Polychloroprene Jacket for Wire and Cable

G. Electrical Testing Laboratories (ETL): Provide wiring, cabling and connector products which are ETL listed and labeled.

H. Institute of Electrical and Electronics Engineers (IEEE): Comply with the following standards which apply to wiring systems:

1. 82: Test procedure for Impulse Voltage Tests on Insulated Conductors
2. 241: Recommended Practice for Electric Power Systems in Commercial Buildings

I. NFPA: Comply with NFPA 70 requirements for construction, installation and color coding of electrical wire, cable and connections.

J. National Electrical Manufacturer's Association (NEMA): Comply with requirements of the following:

1. WC3: Rubber-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
2. WC5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

K. UL: Provide material conforming to the following standards:

1. UL 83 - Thermoplastic-Insulated Wires and Cables.
2. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors
3. UL 854 - Service-Entrance Cables

L. UL Labels: Provide wiring, cabling and connector products which are UL listed and labeled.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver wires and cables according to NEMA WC 26, *Wire and Cable Packaging*.

B. Storage: Store wire and cable in a clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handling: Handle wire and cable carefully to avoid abrading, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

1.6 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer and Architect.

C. Determine required separation between cables and other work.

D. Determine cable routing to avoid interference with other work.

1.7 PROJECT CONDITIONS

A. Verify that field measurements are as shown on the Drawings.

B. Conductor sizes are based on copper.

C. Wire and cable routing shown on Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

D. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wires and Cables:

   a. Southwire Company. (Basis of Design)
   b. American Insulated Wire Corp.; Leviton Manufacturing Co.
   c. BICC Brand-Rex Company.
   d. Carol Cable Co., Inc.
   e. Senator Wire & Cable Company.
   f. Colonial Wire Company

2. Connectors and Accessories for Wires and Cables:

   a. AMP Incorporated.
   b. Buchanan.
   c. General Signal; O-Z/Gedney Unit.
   d. Monogram Company; AFC.
   e. NSI Industries, Inc.
   f. Square D Company; Anderson.
   g. 3M Company; Electrical Products Division.

3. Metal Clad (MC) Cable and Connectors

   a. Alcan Cable
   b. Atkore AFC Cable Systems
   c. Encore Wire Corporation
   d. General Cable
   e. Nexans
   f. Prysmian Cables and Systems
   g. Service Wire Company
   h. Southwire Company
   i. United Copper Industries

2.2 BUILDING WIRES AND CABLES

A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 Article, "*Wire and Insulation Applications*".

B. Rubber Insulation Material: Comply with NEMA WC 3.

C. Thermoplastic Insulation Material: Comply with NEMA WC 5.

D. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC 7.

E. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC 8.

F. Stranding: Solid conductor for No. 10 AWG and smaller; stranded conductor for larger than No. 10 AWG.

G. Conductor: Single conductor annealed copper type.

H. Insulation Voltage Rating: 600 Volts.

I. Conductivity: Minimum of 98 percent at 20 degrees C (68 degrees F) or maximum resistivity of 1.7 micro-ohms per centimeter.

J. Jacket Color: Colors shall be as identified in Article "Wire and Insulation Applications" in Part 3 of this Section.

2.3 CONNECTORS AND SPLICES

A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 Article, "*Wire and Insulation Applications"*.

B. Split Bolt Connectors: Not acceptable.

C. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.

D. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.

E. All wire connectors used in underground or exterior pull boxes shall be gel-filled twist connectors or a connector designed for damp and wet locations.

F. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

G. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

H. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90 degrees C and shall be material flame-retarded per IEEE 383 *Vertical Tray Flame Test*.

I. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer's tolerances.

J. Wire Nut Connectors:

1. Wire nuts installed in wet locations, exterior, etc., shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air.
2. Connectors shall be UL listed and appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating (600 volt minimum).
3. Connector body shall have a color-coded outer shell.
4. Connectors shall be as manufactured by King Technology or approved equal.

2.4 METAL CLAD (MC) CABLE AND CONNECTORS

A. Cable shall meet or exceed the requirements of UL Standard 83, UL Standard 1063, and UL Standard 1569 for Type MC cable, Federal Specification A-A59544 Vertical Cable Tray Flame Test and the National Electrical Code. Cable shall be listed for use in UL 1, 2, and 3 Hour Through-Penetration Firestop Systems.

B. Cable shall be constructed with soft drawn copper, 600 volt, type THHN/THWN conductors rated 90°C dry/75°C wet, with a green insulated grounding conductor. Only cables with conductor sizes 12 AWG and 10 AWG shall be permitted. Conductors shall be cabled together with a binder tape bearing a print legend that is wrapped around the assembly. An aluminum interlocked armor shall be applied over the assembly. Conductors shall be protected by an anti-short bushing at each termination.

C. Straight connectors shall be one-piece spring-steel, set screw design with nylon insulator. Provide cable Lok XC-73 series, as manufactured by Steel City, or approved equal.

D. 90°C connectors shall be die cast zinc, clamp type with insulated throat. Provide XC-89 series as manufactured by Steel City, or approved equal.

2.5 INSULATING TAPE, PUTTY, RESIN AND SUPPORTS

A. Tape: Provide plastic electrical insulating tape which is flame-retardant, cold and weather-resistant. Tape for use in areas subject to temperatures 30 degrees C to 105 degrees C, or where the tape will be subjected to an oil splash, tape shall have a minimum thickness of 8.5 mils, and shall consist of an oil-resistant acrylic adhesive.

B. Materials: Provide all insulating materials for splices and connections such as glass and synthetic tapes, putties, resins, splice cases, or compositions of the type approved for the particular use, location, voltage and temperature and apply and install in an approved manner, all in accordance with the manufacturer's recommendations.

C. Supports: Provide cable supports of the wedge type which firmly clamp each individual cable and tighten due to the cable weight.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine raceways and building finishes to receive wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. By beginning work, the Contractor has accepted conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.3 WIRE AND INSULATION APPLICATIONS

A. Building wire, unless otherwise indicated shall be 600 volt, Type THWN or THHN for #8 AWG wire and smaller, and Type THWN or THW for #6 AWG wire and larger for interior use, and Type THWN or THW insulation for underground or exterior installations outside building installation. Conductors shall be sized and run as indicated.

B. No branch circuit wires smaller than #12 AWG shall be used unless otherwise indicated. Conductors shall be continuous from outlet to outlet and from terminal board to point of final connection, and no splice shall be made except within outlet or junction boxes. All conductors shall be of the size indicated. All wires #8 AWG and larger shall be stranded.

C. Control wiring shall not be less than #14 AWG and shall be color coded using colors impregnated into the insulation. All wiring, contacts, and terminal blocks shall be suitably tagged for ease in identification and tracing of circuits. Identification tags shall be engraved fiber or plastic type, subject to acceptance. Wires shall be numbered and coded, using Brady *Quicklabels,* or equal.

D. A color coding system, as listed below, shall be used throughout the building's network of feeders and circuits and used as a basis of balancing the load. The following color coding shall be used unless an existing system has used a different color code. If this situation occurs obtain approvals prior to installation. Selection shall be based on applicable work covered by this Contract.

System	**Color**				
	Phase A	Phase B	Phase C	Neutral	Ground
208Y/120V	Black	Red	Blue	White	Green

480Y/277V	Brown	Orange	Yellow	Gray	Green

1. Wiring in sizes up to #8 AWG shall have colored insulation. Wiring in sizes #6 AWG and larger may be coded by colored tape for 6 inches of insulation on both ends of conductor. The wiring shall be tagged at terminations, in pull boxes, junction boxes, outlet boxes, panelboards, handholes, etc…
2. All emergency wiring shall have the same color coding but shall clearly be identified as emergency in all outlets, fixtures, etc. All emergency wiring shall be installed in a dedicated conduit system.
3. Switch leg wire shall be labeled with "*S*" tag.

E. All control wiring shall be color coded with wires of colors different from those used to designate phase wires.

F. Wiring for general 15 and 20 amp 120 volt and 277 volt branch circuit work shall be as follows unless otherwise indicated:

HOME RUN LENGTH AND WIRE SIZE						CIRCUIT LENGTH AND WIRE SIZE					
120 Volt			277 Volt			120 Volt			277 Volt		
0 – 60 '	-	#12	0 – 175 '	°	#12	0-100 '	-	#12	0 – 200 '	-	#12
60 – 100 '	-	#10	175 - 350'	°	#10	100 & Up	-	#10	200 ' & Up	-	#10
100' & Up	-	#8	350> & Up	°	#8						

G. Circuit length as given above shall be the wire length between the first and last outlet on the circuit. Home run length as given above shall be the wire length between the first outlet and the panelboard. In accordance with the above, where the size of branch circuit conductors is increased by the minimum required by the NEC for the branch circuit rating, ensure that the termination provisions of all equipment connected to such circuits are listed as suitable for the conductor sizes involved.

H. Joints of #10 AWG and smaller shall be made with properly insulated solderless type pressure connectors. Where stranded conductors or multiple solid conductors are connected to terminals, solderless lugs manufactured by Thomas and Betts Company or equivalent shall be used.

I. Joints of #8 AWG and larger in power and lighting circuits shall be of the type indented into the conductor by means of a hand or hydraulic pressure tool. Connectors shall be Burndy *Hy-dent*, T&B *Sta-Kon*, or equivalent. Connectors for control wiring shall be Burndy *Hy-Lug*, or equivalent.

J. Branch circuits for lighting and power concealed in ceilings and drywall partitions may be accomplished by utilizing type MC (metal clad) cable. Cables shall be supported with appropriate hangers and shall be bundled/train with cable ties. Tie wire will not be accepted.

K. All circuits for exterior electric work shall be #10 AWG (minimum) and contain an extra #10 AWG (minimum) copper ground conductor. All exterior wiring shall be installed in conduit as specified above, unless otherwise noted on the Drawings.

3.4 INSTALLATION

A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's *Standard of Installation*.

B. Remove existing wires from raceway before pulling in new wires and cables.

C. Pull Conductors: Use a UL-listed and 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. Completely and thoroughly swab conduit system before installing conductors.

E. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section, *Common Work Results for Electrical* and Division 26 Section, *Hangers and Supports*.

G. Seal around cables penetrating fire-rated elements according to Division 26 Section *Electrical Firestopping*.

H. Identify wires and cables according to Division 26 Section, *Electrical Identification*.

I. Conductors installed in parallel shall be of equal lengths.

J. Wiring at Outlets: Install with at least 12 inches (300 mm) of slack conductor at each outlet.

K. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

L. The Contractor shall provide suitable installation equipment to prevent cutting and abrasion of conductor insulation. The Contractor shall use suitable cable guides, pulleys, and protective sleeving to prevent damage to cable during installation. Ropes used for pulling of wire and cable shall be made of polyethylene or other suitable non-metallic material. Pulling lines shall be attached to cable by means of either woven basket grips or pulling types attached directly to the conductors. Wire pulling lubricants, if used, shall conform to UL requirements applicable to the various insulations and raceway materials. The lubricants shall be certified by the manufacturer to be non-injurious to such insulation and materials.

M. Each cable shall be labeled at terminals and at all accessible points in equipment and in pull boxes. Each control wire shall be labeled at both ends. Labels shall be self-sticking wire markers.

N. Riser cables shall have cable supports as required by Code.

O. For rubber and plastic-covered wire and cable, pulling compound Ideal Yellow 77 may be used.

P. Terminal lugs for wires #8 AWG and larger shall be T&B 54,000 Series or Burndy *HY-Dent*, compression type, unless noted otherwise. One-hole lugs for #4/0 AWG and smaller. Two-hole lugs for all sizes #250 kcmil AWG and larger.

Q. Install wires and cables using braided rope larger than the cable being pulled to keep twists to a minimum.

R. Provide an insulated green. Equipment Grounding Conductor (EGC), sized per NEC for all feeder and branch circuits whether called for or not.

S. Install electrical cables, wires, and connectors as indicated in compliance with manufacturer's written instructions, applicable requirements of NEC and NECA's "Standard of Installation", and in accordance with recognized industry practices.

T. Coordinate cable and wire installation work with electrical raceway and equipment installation work, as necessary for proper interface.

U. Conductors installed in runs within 6 inches of heating pipes or equipment shall be type AVA.

V. No conductors shall be drawn into conduit until all work, which may cause cable damage, is completed.

W. All wiring in fluorescent fixture channels and in other high ambient temperature areas, shall be of types required by NEC.

X. During installation, do not deform cable by improper bending, stretching, twisting, kinking, or pinching, nor do any other abusive handling. Any failure to observe these instructions will be detected and corrected during the demonstrations following completion of the installation. All cable runs shall contain *"S"* loops or other means to accommodate expansion or contraction as required. Cable bends will have a radius not less than the value recommended by the cable manufacturer. Cable connected to electronic equipment in the system shall be tagged to show its function and the location of its other end. All labels shall be of durable material and securely fastened to the cable.

3.5 CONNECTIONS

A. Conductor Splices: Keep to minimum.

B. Install splices and taps that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.

C. Use splices and taps connectors compatible with conductor material.

D. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Wire splices and taps shall be adequate to carry full current rating of wire.

G. Splices and taps in wires up to #8 AWG shall be made with *Scotch-lok* or T&B PT Series or Ideal Wing Nut insulated electrical connectors. Wire nuts installed in wet location boxes shall be silicon gel-filled. For wires #8 AWG and larger, use copper solderless connectors covered with insulating molded body and then wrapped with electrical tape. Use twist-on wire connectors for connecting lighting fixtures and small motor leads up to #8 AWG wire.

H. Conductors shall be continuous from outlet to outlet, and no splices shall be made except within outlet or junction boxes. Junction boxes may be utilized where required. Wire connectors of insulating material or solderless pressure connections, properly taped, shall be utilized for all splices in wiring.

I. Splices in branch circuits and feeders shall be made where indicated or as required for the installation. All splices shall be accessible and made in enclosure approved for that purpose.

J. For splices in branch circuits and feeders, provide connectors as follows;

1. Wire Sizes #14 AWG to #10 AWG: Provide Ideal Model 74B or 76B or equivalent by T&B.
2. Wire Sizes #8 AWG and Larger: Provide Ideal Model Series AGP-//and GT-// or equivalent by Burndy, O-Z, or T&B. All splices shall be enclosed in insulating molded thermoplastic, rubber, or rubber-like covers or shall be wrapped with Bishop No. 111 or equivalent insulating tape in accordance with the Manufacturer's directions.

K. Thoroughly clean wiring prior to installing lugs or connectors.

3.6 IDENTIFICATION

A. Interface with Other Work:

B. Comply with the requirements of Division 26 Section, *Electrical Identification.*

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing agency to perform field quality-control testing. At the Contractor's discretion, the contractor may execute the required testing. Assumption of the test execution does not mitigate the submission requirement for documentation showing successful testing of all required conductors and cables.

B. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.3.1. Certify compliance with test parameters.

C. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

D. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.

E. Verify continuity of each branch circuit conductor.

F. Tests: Feeder insulation shall be tested after installation, and before connection to fixtures and appliance.

1. Tests shall be performed with a 500-volt megger, and conductors shall test free from short-circuits and grounds.
2. Conductors shall be tested phase-to-phase and phase-to-ground.
3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Owner's Representative.
4. Actual test readings shall be recorded.
5. Submit all test reports to the Architect and Engineer for approval.

G. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

DIVISION 26
SECTION 260524
MEDIUM VOLTAGE GROUNDING
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SECTION 260524 - MEDIUM VOLTAGE GROUNDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2 SECTION INCLUDES

A. Medium voltage grounding.

B. Substation grounding.

1.3 REFERENCES

A. ANSI/IEEE 32 - Requirements, Terms and Test Procedures for Neutral Grounding Devices.

B. ANSI/IEEE C2 - National Electrical Safety Code.

C. ANSI/IEEE 80 - Guide for Safety in Substation Grounding.

D. ANSI/IEEE 81 - Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.

1.4 SYSTEM DESCRIPTION

A. The medium voltage system utilized is 12 kV (DELTA) connected.

1.5 PROJECT RECORD DOCUMENTS

A. Submit documents under provisions of Division 01.

B. Accurately record exact locations of neutral and equipment grounding points and ground electrodes.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/IEEE C2.

B. The underground distribution system shall be properly grounded, meeting all requirements of the National Electric Code, other applicable Federal, State and local electric codes, and the requirements of these specifications.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the International Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association to supervise on-site testing specified in Part 3.

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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 CONDUCTORS

A. Bare Copper Conductors

1. Stranded Conductors: ASTM B 8.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities

having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors: Copper or copper alloy, bolted pressure-type, with at least two bolts.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING ELECTRODES

A. Ground Rod: Copper-clad, ¾ inch in diameter by 10 feet long. Refer to Division 26 Section, "Grounding and Bonding" for additional requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install grounding equipment in accordance with specifications and drawings

B. System shall include, but not be limited to, the following:

1. Ground rods for grounding the underground system shall be installed at every manhole, and transformer.
2. Each manhole shall contain a ground rod driven below the manhole, but with an accessible top. Refer to Drawings for details of manhole grounding.
3. Provide #1/0 AWG 600 Volt insulated, stranded copper ground wire with THWN insulation in each duct with medium voltage cables and bond at each manhole and termination point.

3.2 FIELD QUALITY CONTROL

A. Test resistance to earth of grounding connections in accordance with ANSI/IEEE 81. Use two-point method test to determine resistance between main system and neutral. Test cable in accordance with NETA ATS (Acceptance Testing Specifications), Section 7.14, for electrical power distribution equipment.

B. Maximum Acceptable Ground Resistance; 5 ohms.

C. A resistance of not greater than 5 ohms shall be required at all medium-voltage equipment pads, manholes, etc. Ground resistance shall be measured in normally dry conditions, not less than 48 hours after a rainfall. Where a 5 ohm reading cannot be obtained, additional ground rods may be driven and connected to others in order to obtain a resistance less than 5 ohms.

D. Investigate levels which exceed the above.

END OF SECTION

DIVISION 26
SECTION 260526
GROUNDING AND BONDING
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SECTION 260526– GROUNDING AND BONDING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

B. Bond the electrical service system neutral to ground at service entrance equipment.

C. Bond each separately-derived system neutral to nearest grounding system.

D. Provide communications system grounding conductor at point of service entrance and connect to grounding system.

E. Bond together system neutrals; service equipment enclosures; exposed non-current carrying metal parts of electrical equipment; metal raceway systems; grounding conductor in raceways; receptacle ground connectors; and plumbing systems.

F. Provide ground bus bars with grounding connections to grounding electrodes, domestic water service, lightning protection circuit, etc… as indicated on the Drawings.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data for grounding rods, conductors, connectors and connection materials, and grounding fittings. Submit ground system manufacturer's recommended installation procedure for review.

C. Qualification data for firms and persons specified in *Quality Assurance* Article to demonstrate their capabilities and experience. Include lists of completed projects with

project names and addresses, names and addresses of architects and owners, and other information specified.

D. Field tests and observation reports certified by the testing organization and indicating and interpreting the test reports for compliance with performance requirements.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the International Electrical Testing Association (NETA).

1. Testing Agency Field Supervision: Use persons currently certified by NETA or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Comply with NFPA 70 - National Electrical Code.

C. Comply with UL 467 - UL Standard for Safety Grounding and Bonding Equipment.

D. Comply with ANSI/EEE C2 - National Electrical Safety Code.

E. Comply with ANSI/IEEE 32 - Requirements, terms and test procedures for neutral grounding devices.

F. Comply with IEEE Standard 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.

G. Comply with ANSI C33.8.

H. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled*: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Erico Inc.; Electrical Products Group.
2. Heary Brothers Lightning Protection Co.
3. Ideal Industries, Inc.
4. ILSCO.
5. O-Z/Gedney Co.
6. Raco, Inc.
7. Thomas & Betts, Electrical.

2.2 GROUNDING AND BONDING PRODUCTS

A. Governing Requirements: Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS

A. Comply with Division 26, Section “Conductors and Cables”. Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductors: Insulated with green color insulation, size as indicated on the Drawings, or as required by 2008 National Electrical Code (NEC) Table 250-122, whichever is larger.

C. Grounding-Electrode Conductors: Stranded cable. Size as indicated on the Drawings, in the Specifications, or as required by 2008 National Electrical Code (NEC) Table 250-66, whichever is larger.

D. Underground Conductors: Bare, tinned, stranded, #4/0 AWG size minimum, except as otherwise indicated.

E. Bare Copper Conductors: Conform to the following:

1. Solid Conductors: ASTM B 3.
2. Assembly of Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.

2.4 MISCELLANEOUS CONDUCTORS

A. Grounding Bus: Bare, annealed-copper bars of rectangular cross section, minimum size ¼-inch x 2-inch.

B. Braided Bonding Jumpers: Copper tape, braided No. 3/0 AWG bare copper wire, terminated with copper ferrules.

C. Bonding Straps: Soft copper, 0.05 inch (1 mm) thick and 2 inches (50 mm) wide, unless otherwise indicated.

2.5 CONNECTOR PRODUCTS

A. Mechanical Connectors

1. The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper ally material. Bolts, nuts, washers and lockwashers shall be made of silicon bronze and supplied as a part of the connector body and shall be of the two-bolt type.
2. Split bolt connector types are NOT allowed.
3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.

B. Compression Connectors

1. The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99 percent by IACS Standards.
2. The connectors shall meet or exceed the performance requirements of IEEE 837, latest revision.
3. The installation of the connectors shall be made with a compression, tool and die system, as recommended by the manufacturer of the connectors.
4. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compression tool settings.
5. Each connector shall be factory filled with an oxide-inhibiting compound.

C. Exothermic Connections: Provide exothermic-weld kit selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6 GROUNDING ELECTRODES

A. Grounding Rods: Copper-clad rod with rigid steel core.

1. Size: 3/4 inch by 120 inches (19 by 3000 mm). Provide the number of rods required to obtain proper ground resistance.
2. Rods shall have a minimum of ten (10) mils of copper.
3. Ground rods shall be UL listed #467.

B. Plate Electrodes: Copper, square or rectangular shape. Minimum 0.10 inch (3 mm) thick, size as indicated.

PART 3 - EXECUTION

3.1 APPLICATION

A. Equipment Grounding Conductors: Comply with NEC Article 250 for types, sizes, and quantities of equipment grounding conductors, except where specific types, larger sizes, or more conductors than required by NEC are indicated.

1. Install Equipment Grounding Conductor (EGC) with circuit conductors for the items below in addition to those required by Code:

    a. Feeders and branch circuits.
    b. Lighting circuits.
    c. Receptacle circuits.
    d. Single-phase motor or appliance branch circuits.
    e. Three-phase motor or appliance branch circuits.
    f. Flexible raceway runs.
    g. Metal-clad cable (MC) runs.

2. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120 V and above, including air cleaners and heaters. Bond conductor to each unit and to air duct.
3. Water Heater Circuits: Install a separate equipment grounding conductor to each electric water heater. Bond conductor to heater units, piping, connected equipment, and components.

B. Separately Derived Systems: Where NEC requires grounding, ground according to NEC Article 250-26.

3.2 INSTALLATION

A. General: Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

B. Electrical Room Grounding Bus: Space 1 inch (25 mm) from wall and support from wall 6 inches (150 mm) above finished floor, except as otherwise indicated.

C. Grounding Rods: Locate a minimum of 1-rod length from each other and at least the same distance from any other grounding electrode.

1. Drive until tops are 24 inches (50 mm) below finished floor or final grade, except as otherwise indicated.
2. Interconnect with grounding-electrode conductors using exothermic welds. Make these connections without damaging copper coating or exposing steel.

D. Grounding Conductors: Route along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

E. Underground Grounding Conductors: Use bare copper wire. Bury at least 24 inches (600 mm) below grade.

F. Metal Water Service Pipe: Provide insulated copper grounding conductors, sized as indicated, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding-clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Do not install a grounding jumper across dielectric fittings. Bond grounding-conductor conduit to conductor at each end.

G. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with grounding-clamp connectors.

H. Grounding shall satisfy requirements of the applicable publications. All exposed noncurrent-carrying metallic parts of electrical equipment, metallic raceway systems, grounding conductor in nonmetallic raceways, and grounded conductors of the wiring system shall be grounded.

I. The grounded conductor (neutral) of the wiring system shall be connected to the system grounding conductor at a single place in the system by removable bonding jumpers, sized according to the applicable provisions of the National Electrical Code. The grounded conductor (neutral) to the grounding conductor connection shall be located in the enclosure for the system's overcurrent protection or where otherwise indicated on the Drawings or Specifications.

J. Ground buses and neutral buses in all distribution panelboards, switchboards, panelboards, and those provided in any equipment shall be isolated except where required to be connected as specified above for the service entrance and in transformer terminal compartments.

K. Equipment grounding conductors shall be extended from the ground bus in the distribution equipment to the receptacle, fixture or device lugs where they are provided. When not provided, they shall be connected to equipment enclosures. The connections shall be arranged such that removal of receptacle, the equipment grounding conductors, or ground jumpers from ground busing, shall not affect the system ground.

L. Ground bus shall be provided as indicated on the Drawings or as necessary to provide termination for equipment grounding conductors. Non-current carrying metal parts of electric equipment shall be effectively grounded by bonding to the bus. The ground bus shall be bonded to both the system neutral and the service ground.

M. Raceways shall not be considered as a grounding conductor. Each power, lighting, or control raceway shall have a separate equipment grounding conductor installed. Receptacles shall have a separate grounding pole. All switchgear and bus duct shall be equipped with a grounding bus separate from the neutral bus.

3.3 CONNECTIONS

A. General: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.
3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

B. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections. Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment Grounding-Wire Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.

D. Non-Contact Metal Raceway Terminations: Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically non-continuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. Where these requirements are not available, use those specified in UL 486A and UL 486B.

F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by manufacturer of connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

G. Moisture Protection: Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.4 UNDERGROUND DISTRIBUTION SYSTEM GROUNDING

A. Grounding System: Ground pad-mounted equipment and noncurrent-carrying metal items by connecting them to underground cable and grounding electrodes.

3.5 FIELD QUALITY CONTROL

A. Independent Testing Agency: Engage an independent electrical testing organization to perform tests described below.

B. Tests: Subject the completed grounding system to a megger test at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at ground test wells. Measure ground resistance not less than 2 full days after the last trace of precipitation, and without the 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. Perform tests by the 2-point method according to IEEE 81.

C. Maximum grounding to resistance values are as follows:

1. Equipment Rated 500 kVA and Less: 10 ohms.
2. Equipment Rated 500 to 1000 kVA: 5 ohms.
3. Equipment Rated More than 1000 kVA: 3 ohms.
4. Pad-Mounted Equipment: 5 ohms.
5. Manhole Grounds: 10 ohms.

D. Excessive Ground Resistance: Where resistance to ground exceeds specified values, notify Owner promptly and include recommendations to reduce ground resistance and to accomplish recommended work.

E. Report: Prepare test reports, certified by the testing organization, of ground resistance at each test location. Include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results. Submit all tests to the Engineer for approval.

3.6 ADJUSTING AND CLEANING

A. Restore surface features, including vegetation, at areas disturbed by work of this Section. Reestablish original grades, except as otherwise indicated. Where sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Maintain restored surfaces. Restore disturbed paving as indicated.

3.7 PROJECT RECORD DOCUMENTS

A. Accurately record actual locations of grounding electrodes and all primary grounding locations (i.e., water piping connection, building steel, etc.)

END OF SECTION

DIVISION 26
SECTION 260528
ELECTRICAL FIRESTOPPING
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SECTION 260528 - ELECTRICAL FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section includes:

1. Through-penetration firestopping in fire rated construction.
2. Through-penetration smoke-stopping in smoke partitions.

B. Related items: Raceway seals and manufactured electrical devices: Refer to Division 26 Section, "Raceways and Boxes".

1.3 REFERENCES

A. Underwriters Laboratories

1. UL Fire Resistance Directory

a. Through-penetration firestop devices (XHCR)
b. Fire resistance rating (BXUV)
c. Through-penetration firestop systems (XHEZ)
d. Fill, void, or cavity material (XHHW)

B. American Society for Testing and Materials Standards: ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.4 DEFINITIONS

A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.

B. Barriers: Time-rated fire walls, smoke barrier walls, time rated ceiling/floor assemblies and structural floors.

C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.

D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.

E. System: Specific products and applications classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.

F. Sleeve: Metal fabrication or pipe section extended through thickness of barrier and used to permanently guard penetration. Sleeves are described as part of penetrating system in other Sections and may or may not be required.

1.5 SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption.
2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction and at all separations required to permit building movement and sound or vibration absorption.

1.6 SUBMITTALS

A. Submit in accordance with Division 01, unless otherwise indicated.

B. Product Data: Manufacturer's specifications and technical data including the following:

1. Detailed specification of construction and fabrication.
2. Manufacturer's installation instructions.

C. Shop Drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.

1. Details of each proposed assembly identifying intended products and applicable UL system number, or UL classified devices.
2. Manufacturer or manufacturer's representative shall provide qualified engineering judgment and drawings relating to non-standard applications as needed.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having

recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.7 QUALITY ASSURANCE

A. Installer's qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:

1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
2. At least 2 years experience with systems.
3. Successfully completed at least 5 comparable scale projects using this system.

B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.

C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

D. Manufacturer shall be a member of the International Firestop Council (IFC).

1.8 DELIVERY, STORAGE, AND HANDLING

A. Packing and shipping:

1. Deliver products in original unopened packaging with legible manufacturer's identification.
2. Coordinate delivery with scheduled installation date, allow minimum storage at site.

B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instructions.

1.9 PROJECT CONDITIONS

A. Existing conditions:

1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

B. Environmental requirements:

1. Furnish adequate ventilation if using solvent.
2. Furnish forced air ventilation during installation if required by manufacturer.
3. Keep flammable materials away from sparks or flame.
4. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.

1.10 GUARANTEE

A. Submit copies of written guarantee agreeing to repair or replace joint sealers which fall in joint adhesion, extrusion resistance, migration resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be two years from date of Substantial Completion unless otherwise noted.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Hilti.
2. 3M
3. Nelson.

2.2 THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

A. Systems of devices listed in the UL Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrate type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.

1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the UL system or device, and designed to perform this function.
2. Acceptable manufacturers and products.

a. Those listed in the UL Fire Resistance directory for the UL System involved and as further defined in the “System and Applications Schedule” in Part 3 of this Section.
b. All firestopping products must be from a single manufacturer.

2.3 SMOKE-STOPPING AT SMOKE PARTITIONS

A. Through-penetration smoke-stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in "The Systems and Applications Schedule" in Part 3 of this Section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.4 ACCESSORIES

A. Fill, void or cavity materials: As classified under category XHHW in the UL Fire Resistance Directory.

B. Forming materials: As classified under category XHKU in the UL Fire Resistance Directory.

C. Sleeves: Minimum 24 MSG galvanized steel, 12-inch diameter or smaller steel pipe. Sleeve shall project ½-inch from each surface of the floor/wall. Size as recommended by firestop manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Clean surfaces to be in contact with penetration seal materials of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion, or the required fire resistance.

3.3 INSTALLATION

A. Install penetration seal materials in accordance with printed instructions of the UL Fire Resistance Directory and in accordance with manufacturer's instruction.

B. Seal holes or voids made by penetrations to ensure an effective smoke barrier.

C. Protect materials from damage on surfaces subject to traffic.

D. When large openings are created in walls or floors to permit installation of conduits, cable tray, or other items, close unused portions of opening with firestopping materials tested for the application.

E. Install smoke stopping as specified for firestopping.

F. Provide sleeves the full thickness of the assembly being penetrated and cut sleeves to a length of 1-inch more than the over-all thickness of the penetration, or as recommended by the firestop manufacturer.

3.4 FIELD QUALITY CONTROL

A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.

B. Keep areas of work accessible until inspection by applicable code authorities.

C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.5 ADJUSTING AND CLEANING

A. Clean up spills of liquid components.

B. Neatly cut and trim materials as required.

C. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.6 SYSTEMS AND APPLICATION SCHEDULES*

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
Metal Pipe	CAJ1001 CP25S/L, CP25N/S CAJ1006 CS-195+, FS-195+ CAJ1007 FS-195+, 1-inch& 2-inch Wide CAJ1009 2000, 2000+, 2003 CAJ1010 2000, 2000+, 2003 CAJ1012 2000, 2000+, 2003 CAJ1013 2000, 2000+, 2003 CAJ1014 2000, 2000+, 2003 CAJ1015 2000, 2000+, 2003 CAJ1017 FD 150 CAJ1021 FD 150 CAJ1027 MPS-2+ CAJ1044 CP 25WB+ CAJ1052 CP 25S/L, CP 25N/S CAJ1058 2000, 2000+, 2003 CAJ1060 2000, 2000+, 2003 CAJ1063 2000, 2000+, 2003 CAJ1066 CP 25N/S,CP 25S/L, CP 25WB+	WL1001 CP 25 WL1002 FS-195+ WL1003 CP 25WB+,CP 25N/S WL1008 2000+ WL1009 2000+ WL1010 2000+ WL1016 CP 25WB+ WL1017 CP 25WB+,CP 25N/S WL1032 CP 25WB+,CP 25N/S WL1036 FD 150 WL1037 CS-195+,FS-195+ WL1067 CP 25N/S WL1073 CP 25WB+ WL1080 MPS-2+ WL1082 2000+	FC1002 CP 25 FC1003 2000,2000+,20003 FC1006 CP 25WB+

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
	CAJ1091 CP 25N/S,CP 25S/L, CP 25WB+ CAJ1092 CP 25WB+ CAJ1112 FS-195+ CAJ1160 CP 25S/L, CP 25N/S CAJ1175 CP 25WB+ CAJ1176 CP 25WB+ CAJ1188 2000+ CBJ1020 CS-195+, FS-195+ CBJ1021 CS-195+, MPS-2+ CBJ1031 2001 CBJ1032 2001 FA1002 CP 25WB+ WJ1010 CP 25WB+ WJ1023 2001		
Non-Metallic	CAJ2001 FS-195+, 1-inch& 2-inch WIDE, PPD'S CAJ2002 FS-195+ CAJ2003 CS-195+, FS-195+ CAJ2005 FS-195+ CAJ2006 FS-195+ CAJ2013 FS-195+ CAJ2019 2000, 2000+, 2003 CAJ2027 FS-195+, CP 25N/S, CP 25S/L, CP 25WB+ CAJ2028 FS-195, MPS-2+ CAJ2029 FS-195+, PPD'S CAJ2030 CS-195+, FS-195+ CAJ2040 FS-195+, CP 25WB+ CAJ2044 FS-195+, CP 25N/S, CP 25S/L CP 25 WB+ CAJ2090 FS-195+ CAJ2177 FS-195+, PPD'S FA2001 FS-195+, PPD'S FS2002 CS-195+, FS-195+, MPS-2+, PPD'S FA2011 FS-195+ WJ2012 FS-195+ 1-inch WIDE	WL2002 FS-195+, PPD'S WL2003 FS-195+ WL2004 FS-195+ WL2005 FS-195+ 4' WIDE WL2006 FS-195+ WL2013 FS-195+ WL2031 CS-195+, FS-195+ WL2032 CS-195+, FS-195+ WL2033 FS-195+ WL2073 FS-195+ 1-inch WIDE	FC2002 FS-195+, PPD'S FC2007 FS-195+, PPD'S FC2008 FS-195+ FC2009 FS-195+, PPD'S FC2024 FS-195+ FC2026 FS-195+ FC2028 FS-195+, 1' & 2-inch WIDE, PPD'S
Insulated Cable	CAJ3001 CP 25N/S, CP 25S/L CAJ3005 CS 195+, FS-195+ CAJ3007 2001 CAJ3009 2000, 2000+, 2003 CAJ3010 2000, 2000+, 2003 CAJ3011 2001 CAJ3014 FD 150 CAJ3015 FD 150 CAJ3021 MPS-2+ CAJ3029 2000, 2000+, 2003 CAJ3030 CP 25WB+ CAJ3031 CP 25N/S, CP 25S/L CAJ3041 2000, 2000+, 2003 CAJ3044 CS-195+, FS-195+ CAJ3058 FS-195+, MPS-2+	WL3001 CP 25, MPS-2+ WL3008 2000+ WL3009 2000+ WL3015 CP 25WB+, CP 25N/S WL3022 2000+ WL3030 FS-195+ WL3031 MPS-2+ WL3032 CP 25WB+ WL3041 2000+ WL3051 CP 25N/S WL3056 CP25N/S WL3062 CP 25WB+	FC3001 CP 25S/L, CP 25N/S FC3002 2000+ FC3003 2000, 2000+, 20003 FC3007 CP 25WB+, MPS-2+ FC3008 FS-195+

PENETRATING ITEM	CONCRETE	GYPSUM	WOOD FLOOR/CEILING
	CAJ3071 CP 25N/S, CP 25S/L CAJ3074 CP 25N/S, CP 25S/L CAJ3075 2001 CAJ3080 CP 25WB+ CBJ3016 CS-195+, FS-195+ CBJ3017 CS-195+, MPS-2+ FA3001 CP 25WB+ FB3004 CS-195+, MP WJ3015 2001 WJ3016 2001		
Mixed Penetrating Items Combos	CAJ8001 CS-195+ FS-195+ CAJ8003 2000, 2000+, 20003 CAJ8004 2000, 2000+, 20003 CAJ8006 2001 CAJ8013 FS-195+, CP 25 CBJ8004 CS-195, FS-195+ CBJ8005 CS-195+, MPS-2+ CBJ8008 2001 FA8001 FS-195+, CP 25WB+	WL8002 CS-195+, FS-195+	

* Underwriter's Laboratories, Inc., Fire Resistance Directory.

END OF SECTION

DVISION 26
SECTION 260529
HANGERS AND SUPPORTS
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SECTION 260529 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Common Work Results for Electrical".

C. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26 Section, "Electrical Firestopping" - for requirements for firestopping at sleeves through walls and floors that are fire barriers.
2. Refer to other Division 26 Sections for additional specific support requirements that may be applicable to specific items.

C. Provide equipment supports consisting of platforms, curbs, concrete pads, gratings, cradles, structural members, hangers, rods, racks, and incidental materials.

D. Provide all labor, supervision, and fabrication. Design and construct supporting structures of strength to safely withstand stresses to which they may be subjected and to properly distribute the load and impact over building areas. Provide all engineering and fabrication as required for installation of support system.

E. Provide hangers, clamps, anchors, inserts, supports, supplementary steel framing, and hardware of the proper size and load capacity to support electrical equipment and raceways, whether indicated on the drawings or not.

1.3 SUBMITTALS

A. General: Submit the following in accordance with conditions of Contract and Division 01 Specification Sections.

B. Product data for each type of product specified.

C. Submit for review, shop/assembly drawings and layout drawings of curbs and equipment supports for major items of equipment.

D. Submit structural calculations for approval. Calculations include stress and deflection analysis. Submit design criteria and selection calculation.

E. Supporting devices and fastening methods shall be subject to the review and approval of the Structural Engineer.

F. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 *National Electrical Code*.

B. Electrical components shall be listed and labeled by UL, ETL, CSA, or other approved, nationally recognized testing and listing agency that provides third-party Certification follow-up services.

C. Installation Standard: Installation shall meet or exceed the National Electrical Contractors Association (NECA) Standard of Installation.

D. Manufacturer's Qualifications:

1. The Manufacturer shall not have had less than ten years' experience in manufacturing Strut Support Systems.
2. The Manufacturer must certify in writing all components supplied have been produced in accordance with an established quality assurance program.

E. Installer's Qualifications:

1. Installer must be a factory-trained manufacturer's authorized representative/installer with not less than five years experience in the installation of Strut Support Systems of this size and conformation.
2. All Strut Support System components must be supplied by a single manufacturer.

F. Standards:

1. Work shall meet the requirements of the following standards:

a. Federal, State and Local Codes.
b. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members - August 19, 1986 Edition, December 11, 1989 Addendum.
c. American Society for Testing and Materials (ASTM).
d. Underwriters Laboratories (UL).
e. National Electrical Code (NEC).

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All material is to be delivered to the work site in original factory packaging to avoid damage to the finish.

B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

1.6 GUARANTEE

A. Separate guarantees shall be issued from the erector and manufacturer, valid for a period of one year against any defects that may arise from the installation or manufacture of the Strut Support System components.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Slotted Metal Angle and U-Channel Systems:

a. American Electric, Kindorf
b. Alstrut
c. Unistrut Diversified Products
d. Power-Strut
e. Thomas & Betts

2. Conduit Sealing Bushings and Accessories:

a. Bridgeport Fittings, Inc.
b. GS Metals Corporation
c. O-Z/Gedney

d. Raco, Inc.

2.2 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion-resistance using approved alternative treatment, finish, or inherent material characteristic. All products shall be hot-dip galvanized.

2.3 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features, as follows:

1. Expansion Anchors - Carbon steel wedge or sleeve type.
2. Toggle Bolts - All steel springhead type.
3. Power-Driven Threaded Studs - Heat-treated steel, designed specifically for the intended application.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Provide plugs with number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish.

E. U-Channel Systems: Sixteen-gauge channels with 9/16-inch-diameter holes at a minimum of eight inches on center in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer.

F. Concrete Equipment Pads:

1. Refer to Division 26 Section “Common Work Results for Electrical” for installation requirements.

G. Floor-Mounted Stands: Construct with structural steel members or steel pipe and fasten with flanges bolted to the floor.

H. Ceiling Suspended Platforms: Construct with steel hangers. Brace and fasten to building structure.

I. Wall-Mounted Platforms: Construct with steel brackets.

2.4 ANCHOR METHODS

A. Hollow Masonry: Toggle bolts or plastic conical type expansion anchors.

B. Solid Masonry: Lead expansion anchors or preset inserts.

C. Metal Surfaces: Machine screws, bolts, or welded studs.

D. Wood Surfaces: Wood screws.

E. Concrete Surfaces: Self-drilling anchors or power-driven studs (non-seismic zones).

2.5 VIBRATION ISOLATION MOUNT TYPES

A. Type DNP (Double Neoprene Pad)

1. Neoprene pad isolators shall be formed by two layers of ¼-inch to 1/16-inch thick ribbed or waffled neoprene, separated by a stainless steel or aluminum plate. Layers shall be permanently adhered together. Pads shall be sized so that they will be loaded within the manufacturer's recommended range.
2. Type DNP isolators shall be formed from one of the following products or approved equal:

a.	Type NR:	Amber/Booth.
b.	Type Korpad:	Korfund Dynamics.
c.	Type WSW:	Mason Industries.
d.	Type NPS:	Peabody Noise Control.
e.	Series Shear Flex:	Vibration Mountings and Control.

PART 3 - EXECUTION

3.1 EXAMINATION

A. The installer shall inspect the work area prior to installation. If work area conditions are unsatisfactory, installation shall not proceed until satisfactory corrections are completed.

3.2 INSTALLATION

A. Installation shall be accomplished by a fully trained manufacturer-authorized installer.

B. Set Strut System components into final position true to line, level and plumb, in accordance with approved Shop Drawings.

C. Anchor material firmly in place. Tighten all connections to their recommended torques.

D. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

E. Coordinate with the building structural system and with other electrical installation.

F. Raceway Supports: Comply with the NEC and the following requirements:

1. Conform to manufacturer's recommendations for selection and installation of supports.
2. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of less than 200 pounds, provide additional strength until there is a minimum of 200 pounds safety allowance in the strength of each support.
3. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
4. Support parallel runs of horizontal raceways together on trapeze-type hangers.
5. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2-inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
6. Space supports for raceways in accordance with Table I of this Section. Space supports for raceway types not covered by the above in accordance with NEC.
7. Support exposed and concealed raceway within one foot of an unsupported box and access fittings. In horizontal runs, support at the box and access fittings may be omitted where box or access fittings are independently supported and raceway terminations are not made with chase nipples or threadless box connectors.
8. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminations.

G. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting disconnects, light fixtures, and other devices.

H. In open overhead spaces, cast boxes threaded to raceways need not be supported separately except where used for fixture support; support sheet metal boxes directly from the building structure or by bar hangers. Where bar hangers are used, attach the bar to the raceways on opposite sides of the box and support the raceway with an approved type of fastener not more than 24 inches from the box.

I. Sleeves: Install in concrete slabs and walls and all other fire-rated walls for raceways and cable installations. For sleeves through fire rated-wall construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables in accordance with requirements of Division 26 Section “Electrical Firestopping”.

J. Conduit Seals: Install water tight seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

K. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including, but not limited to conduits, raceways, boxes, disconnect switches, and control components in accordance with the following:

1. Fasten by means of toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Threaded studs driven by a powder charge and provided with lock washers and nuts may be used instead of expansion bolts and machine screws. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures.
2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4-inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration-and shock-resistant fasteners for attachments to concrete slabs.
4. Concrete (New): Iron or steel inserts. Expander type anchors, specified for existing may be used provided concrete is clear of conduit for drilled depth.
5. Concrete (Existing): Double-plated expander type anchors. Phillips, Hilti, or approved equivalent. Loads shall not exceed 1/4 of tested pullout (or shear) strength.
6. Precast Concrete Plank: Drill hole through plank; bolt hanger rod to 4” x 4” x 1/8” steel plate on top of plank.

L. Tests: Test pull-out resistance of one of each type, size, and anchorage material for the following fastener types:

1. Expansion anchors.
2. Toggle bolts.
3. Power-driven threaded studs.

M. Provide all jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the structural Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener. If fastening fails test, revise all similar fastener installations and retest until satisfactory results are achieved.

N. General Supporting Installations:

1. Provide appropriate concrete anchors for hanger rods. Rods shall be screwed into or extended through frame construction (with washer and nut). Supports shall secure conduit in place, and shall prevent vibration, provide for expansion and contraction and shall make neat appearance. Strap hangers or chains are not permitted.
2. Electrical raceways (conduit and EMT) 1-1/2-inches and smaller shall be secured with 1-hole malleable iron straps or brackets to walls. Trapeze supports shall be used for groups or parallel raceways with raceways secured to trapeze with approved clamps. Individual runs of raceways 2-inches and larger shall be supported by Clevis type hangers.
3. Provide all steel supports including roof curbs for all equipment provided under this Section.
4. Electrical raceway supports to be spaced on the following maximum centers:

a. 3/4-inch to 1-inch conduit - 8 feet
b. 1-1/4-inch and larger conduit - 10 feet

5. Provide additional hangers or steel members to distribute the load among two or more structural members when required or directed.
6. Drilling of new concrete slabs will not be permitted. Anchors and inserts shall be cast in the concrete slabs.

O. Locations:

1. Anchor bolts, sleeves, inserts, hangers, and supports required for the electrical work shall be furnished and installed under Division 26.
2. Coordinate with other trades the location of anchors, sleeves, inserts, and supports and insure that they are properly installed.
3. Openings and sleeves shall be set true to line, level, plumb, and position and shall be set true to line, level, plumb, and position and shall be so maintained during construction. Where sleeves and openings are provided in poured concrete, inspect same during and after concrete is poured to insure proper position and correct any deviation.

P. Hangers and Supports:

1. Provide hangers, angles, channels, and other supports required by field conditions to install items of electrical equipment. Design of supports and methods of fastening to building structure shall be acceptable to the Owner.
2. Use of power-actuated fasteners and devices is permitted in the vertical surfaces of the building only with the following requirements.

   a. For fastening conduits 1-1/2-inch and smaller and lighting fixtures 50 lbs or less.
   b. Load capacity per manufacturers' recommendations.
   c. Fasteners shall be located in the thickest part of the slab.
   d. Devices shall comply with OSHA requirements.

3. Use of lead shield expansion anchors is not permitted.
4. No electrical items shall rest on, or depend for support on suspended ceiling media (tiles, lath, plaster, splines, etc.).
5. In suspended ceilings, support conduits directly from structural slabs, decks (or framing members). Do not support conduits on ceiling suspension members.
6. Support surface or pendant lighting fixtures:

   a. From an outlet box by means of an interposed metal strap, where weight is less than 5 lbs.
   b. From an outlet box by means of a hickey or other direct threaded connection, where weight is from 5 to 50 lbs.
   c. Directly from structural slab, deck or framing member, where weight exceeds 50 lbs.

7. In addition to the above, provide cushioned, swivel type hangers with appropriate outlet boxes for pendant fixtures in mechanical areas. Such hangers shall have a support rating at least twice that of the load supported.
8. Support recessed lighting fixtures:

    a. From ceiling suspension members, where weight is less than 60 lbs.
    b. Directly from structural slab, deck, or framing members, where weight is 60 lbs. or more.

9. Provide weight-distribution facilities, where required so as not to exceed the load bearing capabilities of floor or walls that bear the weight of, or support, electrical items.
10. For point-of-attachment weight of 100 lbs. or less, fasten items as follows:

    a. On wood, use wood screws.
    b. On concrete and solid masonry that is already in place, use self-drilling concrete anchors or expansion bolt and couplings.
    c. On hollow construction, use toggle bolts.
    d. On structural steel, use beam clamps.

11. For point-of-attachment weights from 100 lbs. to 300 lbs., provide supports as follows:

    a. At cast-in-place concrete slabs, use concrete inserts in bottom of slab, with 8" slip-through steel rods set transverse to the reinforcing steel.
    b. At concrete slab already in place, uses 16-inches x 8-inches x ½-inch steel plates at the top of the slab, with through-bolts welded in place. The plates shall be chased in and grouted flush, where no fill is to be applied.

12. For point-of-attachment weights over 300 lbs., provide supports as follows: At cast-in-place concrete slabs, uses 16-inch x 8-inch x ½-inch steel plate, with through bolts welded in place. Top of the plate shall be 1-1/2-inches below the top of the slab or on top of the slab where a fill slab is to be installed.
13. Hangers and supports shall be hot dipped galvanized, unless noted otherwise.
14. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.
15. Trapeze type hangers may be used where several conduits are to be installed at the same elevation. The spacing of such trapeze hangers shall be in accordance with the NEC for the smallest conduit in the run.
16. Vertical conduits shall be supported by heavy wrought iron clamps or collars anchored to construction at each floor.

Q. Inserts:

1. Inserts for suspended items in poured concrete construction shall be malleable-iron concrete inserts, adjustable type with insert nut. Items manufactured by Barrett, Crawford, Elcen, or Grinnell shall be used where applicable.
2. Inserts for surface-mounted items shall be suitable for the composition of the slab, wall, or structure on which installation is to be made.

R. TABLE I: SPACING FOR RACEWAY SUPPORTS

TABLE 1: SPACING FOR RACEWAY SUPPORTS			
Raceway Size (Inches)	No. of Conductors in Run	Location	EMT (Ft.)
		HORIZONTAL RUNS	
3/4	1 or 2	Flat ceiling or wall.	5
3/4	1 or 2	Where it is difficult to provide supports except at intervals fixed by the building construction.	7
3/4	3 or more	Any location.	7
3/4 - 1	3 or more	Any location.	
1 & larger	1 or 2	Flat ceiling or wall.	6
1 & larger	1 or more	Where it is difficult to provide supports except at intervals fixed by the building construction.	10
1 & larger	3 or more	Any location.	10
Any	---	Concealed.	10
		VERTICAL RUNS	
3/4	---	Exposed.	7
1, 1-1/4	---	Exposed.	8
1-1/2 & larger	---	Exposed.	10
Up to 2	---	Shaftway.	10
2-1/2	---	Shaftway.	10
3 & larger	---	Shaftway.	10
Any	---	Concealed.	10
Abbreviations:	EMT	Electrical Metallic Tubing	

3.3 CLEANUP

A. Upon completion of this Section of work, remove all protective wraps and debris. Repair any damage due to installation of this section of work.

3.4 PROTECTION

A. During installation, protect this work from damage.

B. Upon completion of this scope of work, it shall become the responsibility of the General Contractor to protect this work from damage during the remainder of construction on the project and until substantial completion.

END OF SECTION

DIVISION 26
SECTION 260533
RACEWAYS AND BOXES
TABLE OF CONTENTS

SECTION 260533 - RACEWAYS AND BOXES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1. Raceways include the following:

a. EMT.
b. ENT.
c. FMC.
d. IMC.
e. LFMC.
f. LFNC.
g. PVC.
h. PVC externally coated, IMC.
i. PVC externally coated, rigid steel conduits.
j. RGS.
k. RMC.
l. Wireways.

2. Boxes, enclosures, and cabinets include the following:

a. Device boxes.
b. Floor boxes.
c. Outlet boxes.
d. Pull and junction boxes.
e. Cabinets and hinged-cover enclosures.

3. Miscellaneous Products include the following:

a. Expansion/Deflection fittings.
b. Bushings.

B. Related Sections include the following:

1. Division 26 Section “Electrical Firestopping”.
2. Division 26 Section “Hangers and Supports” for raceways and box supports.
3. Division 26 Section “Wiring Devices” for devices installed in boxes and for floor-box service fittings.
4. Division 27 Section, “Miscellaneous Raceway Systems” for raceways and box requirements for communication cabling.

1.3 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. ENT: Electrical Nonmetallic Tubing.

C. FMC: Flexible Metal Conduit.

D. IMC: Intermediate Metal Conduit.

E. LFMC: Liquidtight Flexible Metal Conduit.

F. LFNC: Liquidtight Flexible Nonmetallic Conduit.

G. PVC: Rigid Polyvinyl Chloride Conduit.

H. RGS: Rigid Galvanized Steel Conduit.

I. RMC: Rigid Metal Conduit.

J. RNC: Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Product Data: For raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: Include layout drawings showing components and wiring for nonstandard boxes, enclosures, and cabinets.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 QUALITY ASSURANCE

A. Listing and Labeling: Provide raceways and boxes specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. Comply with NECA's "Standard of Installation" and NECA 101 “Recommended Practice for Installing Steel Conduits”.

C. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

B. Verify routing and termination locations of conduits and boxes prior to rough-in.

C. Conduit routing shown on Drawings is only approximate and diagrammatic. Route conduits as required for a complete conduit and wiring system.

D. Coordinate installation of outlet boxes, mounting heights, orientation, and locations of outlets.

1.7 PROJECT RECORD DOCUMENTS:

A. Accurately record routing of all concealed conduits. Record actual routing of all exposed conduits/larger than 1 inch. Indicate actual locations and mounting heights of outlet boxes, pull and junction boxes, branch circuits, arrangements, etc.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Metal Conduit and Tubing:

a. Allied Tube & Conduit Corporation.
b. Anamet, Inc.; Anaconda Metal Hose.

c. AFC/Monogram Company.
d. Carol Cable Co., Inc.
e. Cole-Flex Corp.
f. Electri-Flex Co.
g. Flexcon, Inc.; Coleman Cable Systems, Inc.
h. Grinnell Co.; Allied Tube and Conduit Div.
i. Monogram Co.; AFC.
j. Spiraduct, Inc.
k. Triangle PWC, Inc.
l. Wheatland Tube Co.

2. Nonmetallic Conduit and Tubing:

a. Anamet, Inc.; Anaconda Metal Hose.
b. Arnco Corp.
c. Breeze-Illinois, Inc.
d. Cantex Industries; Harsco Corp.
e. Certainteed Corp.; Pipe & Plastics Group.
f. Cole-Flex Corp.
g. Condux International; Electrical Products.
h. Electri-Flex Co.
i. George-Ingraham Corp.
j. Hubbell, Inc.; Raco, Inc.
k. Lamson & Sessions; Carlon Electrical Products.
l. R&G Sloan Manufacturing Co., Inc.
m. Spiraduct, Inc.
n. Thomas & Betts Corp.

3. Conduit Bodies and Fittings:

a. American Electric; Construction Materials Group.
b. Crouse-Hinds; Div. of Cooper Industries.
c. Emerson Electric Co.; Appleton Electric Co.
d. Hubbell, Inc.; Killark Electric Manufacturing Co.
e. Lamson & Sessions; Carlon Electrical Products.
f. O-Z/Gedney; Unit of General Signal.
g. Scott Fetzer Co.; Adalet-PLM.
h. Spring City Electrical Manufacturing Co.
i. Thomas & Betts Corporation.

4. Metal Wireways:

a. Hoffman Engineering Co.
b. Keystone/Rees, Inc.
c. Square D Co.

5. Boxes, Enclosures, and Cabinets:

a. American Electric; FL Industries.
b. Butler Manufacturing Co.; Walker Division.

c. Crouse-Hinds; Div. of Cooper Industries.
d. Electric Panelboard Co., Inc.
e. Erickson Electrical Equipment Co.
f. Hoffman Engineering Co.; Federal-Hoffman, Inc.
g. Hubbell Inc.; Killark Electric Manufacturing Co.
h. Hubbell Inc.; Raco, Inc.
i. Lamson & Sessions; Carlon Electrical Products.
j. O-Z/Gedney; Unit of General Signal.
k. Parker Electrical Manufacturing Co.
l. Robroy Industries, Inc.; Electrical Division.
m. Scott Fetzer Co.; Adalet-PLM.
n. Spring City Electrical Manufacturing Co.
o. Thomas & Betts Corp.
p. Woodhead Industries, Inc.; Daniel Woodhead Co.

6. Floor Boxes:

a. Crouse Hinds.
b. Hubbell.
c. Square D.
d. Wiremold.

2.2 METAL CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit: ANSI C80.1 and UL 6.

B. IMC: ANSI C80.6.

C. Plastic-Coated Steel Conduit and Fittings: NEMA RN 1.

D. Plastic-Coated IMC and Fittings: NEMA RN 1.

E. EMT and Fittings: ANSI C80.3, galvanized tubing.

1. Fittings: Compression type, NEMA FB1.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings: NEMA FB 1; compatible with conduit/tubing materials.

2.3 NONMETALLIC CONDUIT AND TUBING

A. ENT: NEMA TC 13.

B. PVC: NEMA TC 2, Schedule 40 or 80.

C. PVC Fittings: NEMA TC 3; match to conduit or conduit/tubing type and material.

D. LFNC: UL 1660.

2.4 METAL WIREWAYS

A. Material: Sheet metal sized and shaped as indicated.

B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

C. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.5 OUTLET AND DEVICE BOXES

A. Sheet Metal Boxes: NEMA OS 1, galvanized flat-rolled sheet steel.

B. Cast-Metal Boxes: NEMA FB 1, Type FD, cast box, deep type, with gasketed cover, and threaded hubs.

C. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including corrosion-resistant screws, mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps, and metal straps for supporting outlet boxes which are compatible with outlet boxes being used and fulfilling requirements of individual wiring situations.

D. Nonmetallic: NEMA OS2.

2.6 PULL AND JUNCTION BOXES

A. Small Sheet Metal Boxes: NEMA OS 1.

B. Sheet metal boxes over 12" in any dimension shall comply with the requirements of Article "Enclosures and Cabinets" of this Section.

C. Boxes for Outdoor and Wet Locations: Flat flanged, surface-mounted, UL listed as raintight, galvanized cast iron box and cover with neoprene gasket and stainless steel cover screws.

D. Boxes for Buried Flush Grade Locations: NEMA 250, Type 6, flat flanged, UL listed as watertight, galvanized cast iron, aluminum or PVC box.

1. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
2. Cover Legend: "Electric" or "Communications" as appropriate.

2.7 BOX EXTENSIONS

A. Prohibited on new construction.

B. Where more than one box is needed to flush out installation, provide a large (i.e., 6" x 6") box to flush out the existing box and nipple over to a new box.

2.8 ENCLOSURES AND CABINETS

A. Hinged-Cover Enclosures: NEMA 250, Type 1 in dry locations, and Type 4 in wet or damp locations, with continuous hinge cover and flush latch.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

B. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage, and include accessory feet where required for freestanding equipment.

2.9 EXPANSION / DEFLECTION FITTINGS

A. Provide an expansion/deflection fitting in each concealed or exposed electrical run crossing a building expansion joint. Fittings shall be complete with bronze end couplings, neoprene sleeves, tinned copper braid integral bonding jumper and stainless steel bands. Expansion/deflection fittings shall be suitable for the size and type of conduit run they connect. Bonding jumper shall comply with NEC and UL requirements.

B. Expansion/deflection fitting shall accommodate the following movements without collapsing or fracturing the conduit and damaging the wires it contains:

1. Axial expansion or contraction up to 3/4-inch.
2. Angular misalignment of the axes of the conduits up to 30 degrees in all directions.
3. Parallel misalignment of the axes of the conduits up to 3/4-inch in all directions.

C. Expansion/Deflection fitting shall be OZ/Gedney Type "DX" or approved equal by Crouse Hinds (Type XD).

2.10 BUSHINGS

A. Bushings for 1-inch conduit and smaller shall be self-extinguishing thermoplastic type - 150°C temperature rating.

B. Bushings for 1-1/4" conduit and larger shall be malleable iron body with 150 degrees C insulating ring. Insulating material shall be locked in place and non-removable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 RACEWAY REQUIREMENTS

A. Conduit Application Schedule:

Application	Conduit Type	Remarks
In or under concrete slab	RGS	
Exposed exterior locations.	RGS	Use threaded or rain-tight fittings.
Wet interior locations.	RGS	Use threaded or rain-tight fittings.
Exposed dry interior locations up to 7'-0" AFF.	RGS	
Exposed dry interior locations above 7'-0" AFF.	EMT	
Exterior Underground	RNC (Sched. 40 PVC)	RGS Elbows/Sweeps
Equipment connections in dry interior locations.	FMC (e.g. Greenfield)	Short lengths only (maximum 6 feet).
Equipment connections in wet interior locations.	LFMC (e.g. Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight fittings.
Equipment connections in exterior locations.	LFMC (e.g Sealtite)	Short lengths only (maximum 6 feet). Use threaded or rain-tight fittings.
Concealed in dry wall construction.	EMT, IMC, RGS, MC Cabling	
Concealed above suspended ceilings.	EMT, IMC, RGS, MC Cabling	

Concealed in masonry walls.	EMT	

1. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) for medium voltage applications, and for interior work embedded in concrete.
2. Provide hot-dip Rigid Galvanized Steel Conduit (RGS), galvanized Intermediate Metal Conduit (IMC) or galvanized Electrical Metallic Tubing (EMT) for concealed work above suspended ceilings and within interior partitions and for exposed interior work above 7'-0".
3. Provide Flexible Metal Conduit (FMC), e.g. Greenfield, in short lengths (maximum 6 feet) for the connection for lighting fixtures, dry type transformers and any vibrating equipment. The flexible connections to recessed fixtures and equipment shall be sufficient slack to permit removal of fixture.
4. Provide Liquidtight Flexible Metal Conduit (LFMC), e.g. Sealtite, in short lengths (maximum 6 feet) for the connection of exterior equipment, motors and equipment in damp or wet locations as defined in Division 26 Section "Common Work Results for Electrical".
5. Provide hot-dip Rigid Galvanized Steel Conduit (RGS) with bonded PVC jacket (Plastic-Bond or Kor-Kap) for work not completely encased in concrete but laid directly in or in contact with ground or on a vapor barrier and additionally, as directed.
6. Aluminum conduit is prohibited.
7. Where indicated on the drawings, Rigid Non-metallic Conduit may be used as permitted in Article 347 of the NEC, with or without concrete encasement. Where rigid non-metallic conduit is exposed, it shall be Schedule 40 PVC, with all provisions for thermal expansion/contraction as recommended by the Manufacturer.
8. Conduits for exterior underground electric work shall be rigid steel, galvanized and sherardized, leaving the building and to points 5 feet beyond footings. Beyond 5 feet of building, underground conduits shall be non-metallic Schedule 40 PVC Type II.
9. All steel conduits from outside terminations to service entrance equipment shall be painted with two heavy coats of asphaltum.
10. Conduits shall slope from entrance equipment toward outside of building.

B. Fittings:

1. All fittings to match conduit material and to be suitable for the purpose intended. Join conduit with fittings designed and approved for the purpose and make joints tight.
2. Provide UL listed compound filled sealing fittings for NEC-required locations, for conduits passing from interior to exterior, and at the interface of widely different space temperatures such as refrigeration or cold storage rooms where conduits pass from warm locations to cool locations, such as the boundaries of air conditioned spaces and non-conditioned air spaces. For concealed conduits, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces.
3. Provide expansion fittings with bonding jumpers where conduits cross expansion joints or where otherwise required to compensate for thermal expansion and contraction. Provide expansion fittings in each straight uninterrupted run of surface-mounted conduit, both horizontal and vertical, in excess of 200 feet. Distance

between fittings shall not exceed 200 linear feet. The Contractor shall refer to the Architectural Drawings for expansion joint locations.

4. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be OZ/Gedney type "B", or equal.
5. Fasten EMT conduit with "Concretight" or "Raintight" compression fittings made from galvanized steel or malleable iron. Fittings using set screw or indentations as a means of attachment or made from cast "white metal" are prohibited. All connectors shall have insulated throats.
6. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.
7. Fasten Flexible Metallic Conduit (FMC) with Thomas & Betts (T&B) "Tite-Bite" insulated connectors, or equal.
8. Watertight fittings shall use a copper base anti-corrosive conductive compound. Provide watertight fittings in conduits exposed to weather, in wet locations, in underground locations, and in slabs.

C. Box Locations:

1. Electrical boxes shall accommodate wire pulling, splices, taps, equipment connections and Code compliance.
2. Coordinate access doors as required to provide access to boxes in hard ceilings and similar inaccessible areas.
3. Provide cast boxes (with threaded hubs) in exterior locations.

D. Outlet Boxes:

1. Outlet boxes for concealed work shall be zinc-coated or cadmium-plated sheet steel boxes suitable for the service and type outlet. Boxes and conduit fittings for outdoor and exposed work shall be NEMA 4 cast-aluminum, cast steel or cast iron type with threaded hubs for conduit entrance. Boxes and conduit fittings for outdoor work shall have gasketed cover plates. Extra large boxes shall be provided in accordance with the National Electrical Code where necessary to prevent crowding of wire in the box. Plastic boxes and cast "white metal" boxes classified as NEMA 4 will not be acceptable.
2. Outlet boxes in unplastered brick or block walls shall be provided with deep square-cut device covers. They shall be set so that the brick or block can be cut and fitted closely to the cover opening and so that the standard wall plate will cover the joint between the brick or block and the box.
3. All outlet boxes used for supporting fixtures shall be furnished with malleable iron fixture studs of "no-bolt" type secured by locknut. Provide support for boxes occurring in suspended ceilings. Outlets in ceilings directly on bottom of joists shall be supported independent of ceiling construction. Outlets in suspended ceilings shall not be supported from ceiling construction.
4. All boxes, whether outlet, junction, pull, or equipment, shall be furnished with appropriate covers.
5. No sectionalized boxes shall be used.
6. Back-to-back outlet boxes are not permitted. Separate boxes a minimum of 6" in standard walls and a minimum of 2 feet in acoustical walls.
7. Provide knockout closures for unused openings.

8. Provide blank coverplates for all unused boxes.
9. For multiple device installations, provide multi-gang boxes. Sectional boxes are not permitted. Provide barrier separation of different voltage conductors in the same box.
10. Thoroughly coordinate mounting heights of boxes with casework and backsplash heights.
11. Provide recessed outlet boxes in finished areas, supported from interior partition studs. Supports are to be stamped steel stud bridges for hollow stud walls and adjustable steel channel fasteners for flush ceiling outlet boxes.
12. Provide back supports for boxes in metal stud walls.

E. Junction and Pull Boxes:

1. Junction and pull boxes shall be furnished and installed as shown or where required to facilitate pulling of wires or cables. Such boxes shall be installed in accessible locations. All boxes for concealed work shall be constructed of 12 gauge USS galvanized sheet steel minimum, unless otherwise specified or indicated and provided with mounting brackets and flat screw covers secured in position by round head brass or stainless steel 300 grade machine screws. Boxes for exterior work shall be cast aluminum or galvanized cast iron type with threaded hubs unless otherwise directed. Gasketed cover plates shall be furnished for outdoor installation. Provide barrier (separation) where different system voltage conductors share the same box.
2. Wherever possible, locate pull and junction boxes above accessible ceilings in finished areas.
3. Pull or junction boxes shall be supported independently of conduit.
4. In flush grade outdoor applications, unit shall be adequately supported against settling or tipping. Where heavy traffic or poor soil compaction exists, cast box in a concrete base which provides 6" of cover around and under the box.

3.3 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Furnish and install a separate and independent raceway system as shown on the Drawings for each of the various wiring systems including, but not limited to, the following:

Access Control System
Communications System
Control Wiring
Fire Alarm System
Incoming Electric Service
Lighting
Power 120/208 volt
Power 277/480 volt
Video Surveillance System
Voice/Data/Video System

1. All raceway systems shall be completely wired as specified herein, shown on drawings and/or required for satisfactory operation of the various systems.
2. Raceways, generally, shall be concealed conduit as specified herein. Where wiring troughs are required or used to facilitate the wiring installation, they shall be equal to Square D Company's Square-Duct and fittings, with hinged cover arranged for total removal, all finished in baked enamel and all components U/L listed. The gutters shall be of ample size to accommodate conductors therein and as required by the NEC.
3. Underground conduits for services outside of building and entrance into building shall be as specified herein.
4. Support all conduit not embedded in concrete or masonry such that strain is not transmitted to outlet boxes and pull/junction boxes, etc. Supports to be sufficiently rigid to prevent distortion of conduits during wire pulling.

C. Minimum Raceway Size: 3/4-inch trade size (DN21).

D. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors.

E. Electrical Metallic Tubing (EMT) shall be used for the following unless otherwise indicated:

1. Branch circuits for lighting, receptacles, and power concealed in:

    a. Dry wall construction.
    b. Suspended ceilings.
    c. Masonry walls.

2. Exposed in equipment room areas as needed to serve fixed equipment.
3. Circuits for communication and signaling concealed in:

    a. Dry wall construction.
    b. Suspended ceilings.

F. Rigid Galvanized Steel Conduit (RGS) shall be used for the following, unless otherwise indicated:

1. Branch circuits and feeders for lighting, receptacle and power, installed exposed in areas subject to physical damage.
2. Circuits for communication and signaling exposed in areas subject to physical damage.

G. Conduit shall be run concealed wherever possible, within walls, ceilings, or floors, unless otherwise indicated or specified. Where exposed conduits runs are shown or required, they shall be run parallel to building construction and shall be suitably supported at required intervals.

H. Conduit may be run exposed in Mechanical Equipment rooms, Electrical rooms, and where necessary in Storage rooms and unfinished areas. Where conduit is run exposed, it shall be

run as close as possible to walls and ceilings and shall not interfere with equipment, ductwork, and piping.

I. Keep raceways at least 12 inches (300 mm) away from parallel runs of flues, hot-water pipes and other hot surfaces above 77 degrees F. Install horizontal raceway runs above water piping.

J. Install raceways level and square and at proper elevations. Provide adequate headroom.

K. Complete raceway installation before starting conductor installation.

L. Support raceways as specified in Division 26 Section "Hangers and Supports". Arrange supports to prevent misalignment during wiring installation.

M. Use capped bushings or "push-penny" plugs to prevent foreign matter from entering the conduit system during construction. Clean and plug or cap all conduits left empty for future use.

N. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Conduit stub-ups and stub-downs shall be arranged in a neat and orderly manner and shall emerge at right angles to floors or ceilings.

O. Make bends and offsets so the inside diameter is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

P. Use raceway fittings compatible with raceways and suitable for use and location. For intermediate steel conduit, use threaded rigid steel conduit fittings, unless otherwise indicated.

Q. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

R. Conduits shall not be installed in elevated concrete floor slabs so that composite action between the slab and beams is not affected. Conduits may be installed in grade level concrete floor slab with the following limitations:

1. Maximum size - 1-1/4".
2. Minimum concrete cover – 1.0", above and below.
3. Minimum spacing between conduits - 6" on center.
4. Conduit outside diameter - 1/3 of slab thickness.
5. Installed between bottom and top reinforcing, and centerline of conduit at the mid-depth of the slab.
6. Secured to prevent possible change in position, sagging, or shifting as concrete is poured.
7. Water or damp-proofing integrity of slab is not disturbed.

S. Conduits larger than 1-1/4" may be installed in concrete floor slabs only with the specific permission of the Engineer, or as specifically indicated on the drawings, all in accordance with the above limitation.

T. Conduits in close proximity to each other at panelboards, etc., shall be located and wrapped with wire mesh to prevent cracking of slab.

U. Transition RNC to RGS before rising above the floor.

V. Space raceways laterally to prevent voids in the concrete.

W. Run conduit parallel to or at right angles to main reinforcement. When at right angles to reinforcement, place conduit close to slab support.

X. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

Y. Run parallel or banked raceways together, on common supports where practical.

Z. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

AA. Join raceways with fittings designed and approved for the purpose and make joints tight.

1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
2. Use insulating bushings to protect conductors.

BB. Tighten set screws of threadless fittings with suitable tools.

CC. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel 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 the pull wire.

DD. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.

EE. Lubricants for pulling wires shall be approved for use with the types of wire and conduit installed.

FF. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

GG. Install hinged-cover enclosures and cabinets plumb. Support at each corner.

HH. Use conduit hubs or sealing lock nuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.

II. Install no more than equivalent of three 90° bends between boxes. Use conduit bodies to make sharp changes in direction, as around beams. Use factory elbows for bends in metal conduit larger than 2 inches (50 mm) in size.

JJ. Avoid moisture traps; provide junction box with drain fittings at low points in conduit system.

KK. Die-cast fittings of pot metal will not be accepted.

LL. Conduits shall be free of any burrs, foreign objects, and water prior to conduit installation.

MM. Conduit placed against concrete or masonry above ground shall be fastened to the concrete or masonry with pipe straps or one screw clamp attached to the concrete by means of expansion screw anchors and screws. "Caddy Clip" type hangers or straps will be permitted only in non-exposed areas and restricted to 3/4" conduit.

NN. Where conduits turn up out of concrete slabs and are not concealed by wall construction, bends shall be carefully made so that no portion of the radius is above the floor.

OO. Rigid Galvanized Steel (RGS) conduit or Electrical Metallic Tubing (EMT) shall not be strapped or fastened to equipment subject to vibration or mounted on shock-absorbing bases.

PP. Conduit shall be installed in such manner as to insure against the collection of trapped condensation, and runs of conduit shall be without traps wherever possible. Drill 1/8" diameter weep holes where necessary.

QQ. Conduits run to and from cabinets shall be run neatly, in accurate manner and shall emerge from the floors and ceilings at right angles thereto.

RR. Provide wall flanges and gasketing on conduits entering fan housings to minimize air leakage at points of penetration of housing.

SS. Conduit risers shall be rigidly supported on the building structure, using appropriate supports only.

TT. Exposed conduit installed on or adjacent to ventilating ducts shall be installed after the ducts are in place, and shall be run from ceiling or wall junction boxes in such manner as to retain accessibility to junction box covers and to permit future removal or replacement of ducts.

UU. Conduits and other electrical items shall not be fastened to, or supported from ventilating ducts but shall be separately supported. The method of supporting and details of the supporting members shall be reviewed by the Owner's Representative. In no case shall screws penetrate the sheet metal of the ducts.

VV. Exposed conduit run on surface shall be supported according to Code and within three feet of each outlet, junction box, or cabinet, by galvanized malleable conduit clamps and clamp backs. Suspended conduits shall be supported every five feet by conduit hangers and round rods, or where two or more conduits are run parallel, by trapeze hangers suitably braced to prevent swaying.

WW. Screws for all exposed work shall be stainless steel, unless otherwise noted.

XX. Cadmium-plated steel screws may be used for interior dry locations only.

YY. No running threads shall be cut or used.

ZZ. Conduits which are installed at this time and left empty for future use and which are five feet or more in length shall have a non-ferrous, 600 lb. tensile strength drag line left in place for future use. All empty conduits including conduit stubs shall be tagged at all exposed ends with tags identifying the location of the end of the conduit.

AAA. In all instances where flush-mounted type panelboards are installed, provide spare (empty) conduits in accordance with schedule in Division 26 Section “Panelboards”, Paragraph “Provision for Future Circuits at Flush-Mounted Panelboards”. These conduits shall extend between the panelboard cabinet and a junction box located above accessible ceiling construction.

3.4 FLEXIBLE CONNECTIONS

A. Use maximum of six (6) feet (1830 mm) of UL listed Flexible Metal Conduit (FMC) for recessed and semi-recessed lighting fluorescent fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use Liquidtight Flexible Metal Conduit (LFMC) in wet or damp locations, as defined per NEC. Flexible conduits shall not be used for indoor HID lighting fixture connections.

B. Grounding conductors with green colored insulation shall be extended through all flexible connections including fixture "whips", and fastened to terminals within the first junction boxes on either side of the flexible length.

C. Flexible connections shall be sized per the Contract Drawings, or as required in accordance with Code; the more stringent requirement shall apply.

3.5 INSTALLATION OF TERMINATIONS

A. Where raceways are terminated with lock nuts and bushings, align the raceway to enter squarely, and install the lock nuts with dished part against the box. Where terminations cannot be made secure with one lock nut, use two lock nuts, one inside and one outside ofthe box.

B. Where terminating in threaded hubs, screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align the raceway so the coupling is square to the box, and tighten the chase nipple so no threads are exposed.

C. Open ends shall be capped with approved manufactured conduit seals as soon as installed and kept capped until ready to pull in conductors.

D. Where conductors No. 8 or larger enter a raceway, cabinet, pull box, and junction box, the conductors shall be protected by an insulated bushing providing a smoothly rounded surface.

E. Double lock nuts shall be used at termination of rigid conduit in knock-out openings.

F. Ends of conduits shall be equipped with insulating bushings for 1" and smaller, and insulated metallic bushings for 1-1/4" and larger. Ends of conduit shall be temporarily capped prior to installation and during construction to exclude foreign material.

3.6 INSTALLATION OF BOXES

A. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors.

B. Set floor boxes level and adjust to finished floor surface.

C. Provide junction boxes, pull boxes, cable support boxes, and wireways as required for proper installation of the electrical work. Covers shall be accessible. Small junction boxes shall be similar to outlet boxes.

D. Pull boxes, cable support boxes, and large junction boxes for indoor use shall be made of Code gauge steel or no less than 12 gauge. Covers shall be held in place with stainless steel screws. Paint interior and exterior surfaces with rust-inhibitive paint. (Pull boxes and covers shall be hot-dipped galvanized.)

E. Pull boxes shall be installed at all necessary points to prevent injury to the insulation or other damage that might result from pulling resistance or for other reasons necessary for proper installation. Pull box locations shall be approved by the Owner's representative prior to installation.

F. Where boxes are used in connection with exposed conduit, plain covers attached to the box with a suitable number of countersunk flat head machine screws shall be used.

G. Pull boxes with barriers shall have a single cover plate and the barriers shall be of the same gauge as the pull box.

H. Exposed pull boxes will not be permitted in finished spaces.

I. Location of pull boxes shall be coordinated with piping, ductwork, and other equipment so as to permit sufficient clearance for maintenance and access.

J. Pull boxes recessed in walls or partitions shall be provided with flanged type covers.

K. Outlet boxes and covers shall be sheet steel knockout type, zinc-coated, or cadmium-plated and shall be of proper Code size for the number of wires of conduits passing through or terminating therein, but in no case shall any box be less than 4" square, or boxes at end of a run and containing a single device may be of the "handy box" type. Covers for flush outlets

shall finish flush with plaster or other finished surface. Approved factory-made knockout seals shall be used in all boxes where knockouts are not intact. Boxes in concrete shall be a type which will allow the placing of conduit without displacing the reinforcing bars. Additional pull boxes shall be installed as required to facilitate pulling of wires.

L. Outlet boxes for lighting fixtures shall be equipped with fixture supporting devices.

M. Outlet boxes for switches shall be of the gang type.

N. Outlet boxes for exterior use shall be of the weatherproof cast metal type, with threaded hubs.

O. Each circuit in each pullbox shall be marked with a tag guide denoting panels to which they connect.

P. Boxes shall be separated to prevent sound transmission. Back-to-back boxes shall not be permitted.

Q. Outlet boxes shall be provided with suitable plaster rings and covers or plates.

R. Unused knockout holes shall remain closed and those opened by error shall be closed with snap-in blanks.

S. Outlet boxes shall not be smaller than required by Code for the number and size of wires to be installed.

T. Outlet boxes installed in plenum ceilings shall be in accordance with applicable codes.

U. Outlet boxes for exposed interior work, in damp or wet locations, and all exterior work shall be cast metal or alloy with screw-fastened covers and gaskets, and with threaded conduit connections. Fasteners shall be stainless steel or brass.

V. Outlet boxes shall be installed true and plumb so that the covers or plates will be level and at uniform elevations for the types of outlets contained.

W. Outlet boxes for toggle switches at doorways shall be located at the strike side of the door as finally hung.

X. Outlet box locations as indicated shall be considered to be approximate only. Determine exact locations from architectural details or from field instructions and coordinate outlet box locations with the work of other trades.

Y. Install junction and pull boxes to be accessible. Boxes in plenum ceilings shall comply with Code requirements.

Z. Locations of junction and pull boxes requiring access panels shall be reviewed by the Owner's Representative.

3.7 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to Manufacturer and Installer that ensure coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

B. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

C. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

D. Steel conduit: Conduit that shows corrosion within the guarantee period shall be replaced.

3.8 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

B. After conduits and accessories have been installed, and concreting operations completed, conduit runs shall be satisfactorily cleared of obstructions and foreign matter. Defects which might damage cable upon installation shall be corrected. Where new conduits installed are connected to existing conduits, the entire run to the nearest box or other termination point shall be cleaned.

END OF SECTION

DIVISION 26
SECTION 260543
UNDERGROUND DUCTBANKS
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SECTION 260543 - UNDERGROUND DUCTBANKS

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.

B. Sections of other Divisions in this Specification which relate to excavation and concrete construction.

C. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes complete concrete ductbank construction and direct burial materials and methods for outside power and communications systems transmission and distribution.

B. Provide adjustment of existing manholes and handholes to set flush with new finished grade level.

C. This section specifies underground duct placement, materials, and installation procedures.

1.3 CONTRACTOR RESPONSIBILITIES

A. All work described in this Section shall be performed and paid for under Division 26.

B. Existing Subsurface Utilities: Existing subsurface facilities are shown on the plans to help the Contractor avoid damage to essential utilities which must remain in service. Take reasonable steps to ascertain the exact location of all underground facilities prior to doing work that may damage such facilities. If the discovery of underground facilities not indicated on the plans or in a location different from what is indicated on the plans, protect such facilities, notify the Owner's representative immediately, and record actual conditions found onto the record drawings.

C. Construction Staking:

1. Provide the stakes and reference marks necessary for the construction of the improvements covered by this Contract.

2. Control stakes which constitute reference points for all Construction work shall be conspicuously marked with red flagging tape. Provide responsibility to inform

employees and Subcontractors of the stakes' importance, and the necessity for their preservation. The cost of replacing such controls, should it become necessary for any reason whatsoever, shall be furnished at no additional cost to the Owner.

1.4 QUALITY ASSURANCE

A. Installer: Company specializing in cast-in-place concrete structures with a minimum of three years documented experience.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1, or an equivalent Certification program.

B. Materials: All materials shall be new and the best of their respective kinds, free from all defects and as specified on the plans and the specifications or as accepted by the Project Engineer. Furnish materials or manufactured articles or shall do work for which no detailed Specifications are set forth, the materials or manufactured articles shall be of the best grade in quality and workmanship obtainable on the market from firms of established good reputation, or if not ordinarily carried in stock, shall conform to the usual standards of first-class materials or articles of the kind required, with due consideration of the use to which they are to be put. In general, the work performed shall be in conformity and harmony with the intent to secure the best standard of Construction and equipment of the work as a whole or in part.

C. Manufacturer's Recommendations: Whether specifically mentioned or not in these Specifications, all materials, equipment, devices, etc., shall be installed in a manner meeting the approval of the manufacturer of the particular item.

D. Codes and Standards: Provide underground ducts and manholes conforming to the following:

1. National Electrical Manufacturers Association (NEMA) - Conform to the manufacturing standards of the following:

a. RNI: PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
b. TC 2: Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
c. TC 3: PVC Fittings for Use with Rigid PVC Conduit and Tubing.
d. TC 6: PVC and BAS Plastic Utilities Duct for Underground Installation.
e. TC 7: Smooth-Wall Coilable Polyethylene Electrical Plastic Duct.
f. TC 8: Extra-Strength PVC Plastic Utilities duct for Underground Installation.
g. TC 9: Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.

2. Underwriters Laboratories, Inc. (UL): Conform to the following:

a. 6: Rigid Metal Conduit.
b. 651: Schedule 40 and 80 Rigid PVC Conduit.

c. 651A: Type EB and A Rigid PVC Conduit and HDPE Conduit.

3. American Concrete Institute (ACI):

a. 318: Building Code Requirements for Reinforced Concrete.

4. American Society for Testing & Materials (ASTM)

a. F512: Smooth-Wall PVC Conduit & Fittings for Underground Installation.

E. Certification: Manufacturer shall be a company specializing in ductbank structures with a minimum five years documented experience.

1.5 SUBMITTALS

A. Submit shop drawings and product data for all conduit, duct, ductbank materials, accessories, and miscellaneous components. Submit product data for each type of manufactured material and product indicated.

B. Indicate material specifications, dimensions, capacities, and reinforcing details. Submit concrete product data, concrete mix design, and certified mill test reports for steel bars.

C. Submit coordination shop drawings of ductbank and underground cable installations including profiles and elevations of all utility crossings. Proposed deviations from details on the Drawings shall be clearly marked on all Submittals.

D. Record Documents: Show dimensional locations of underground ducts, and handholes, and manholes.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.6 SITE CONDITIONS

A. General: Clearing work shall not begin until temporary fences, barricades, warning signs and other pedestrian control devices are installed.

B. Traffic Access:

1. Conduct operations and schedule cleanup in a manner which causes the least possible obstruction and inconvenience to adjacent property owners, pedestrians and vehicular traffic. Furnish, erect, construct and maintain such temporary fences, barriers, lights, reflectors, cones, signs, ramps, etc., that may be necessary to adequately provide separation and warn the public of work in progress and of any existing dangerous conditions. This requirement shall apply continuously and shall not be limited to normal working hours.
2. Provide responsibility for coordinating and obtaining approvals of the location for temporary barricades and/or detours of traffic from the Police and Fire Departments.
3. If peripheral fencing is used, it shall be provided with reflectors, flashers, signs, dangles, or barricades as the fence is being built.
4. Maintain continued access to parking areas, roads, abutting properties, and other facilities which the construction will cross.
5. If traffic is reduced to one way, provide a flag person. A minimum of one lane shall be maintained open to traffic at all times.
6. When entering or leaving road ways carrying public traffic, the equipment whether empty or loaded, shall in all cases yield to public traffic.
7. Supply and maintain cone placements at his sole additional expense.
8. All traffic signs which fall within the line of Construction or are obstructed by the equipment or operations shall be temporarily relocated to an unobstructed area. Temporarily relocated traffic signs shall be returned to their original location at the end of construction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering the specified products that may be incorporated in the work, include, but are not limited to, the following:

1. Conduit and Fittings:

    a. Carlon Electrical Products.
    b. George-Ingraham Corporation.
    c. Condux International.

2. Ductbank Accessories:

    a. Carlon.
    b. Osburn Associates.
    c. Underground Devices, Inc.
    d. OZ/Gedney

2.2 UNDERGROUND DUCTBANKS

A. General: Underground ductbanks to be arrangements of single bore, PVC plastic conduits concrete encased. The number and size of conduits to be as indicated. Turn up connections through slabs or floors shall be rigid metal.

B. Material:

1. Conduit and Fittings:

   a. Type II, heavy wall Schedule 40 PVC plastic, sunlight UV-resistant, in accordance with the requirements of NEMA publications TC-2 and TC-3 (fittings).
   b. Rigid galvanized heavy wall steel conduit (UL 6) with threaded couplings.
   c. Rigid Metal Conduit, PVC Coated, UL 6, galvanized steel, threaded type, coated with a polyvinyl chloride (PVC) sheath bonded to the galvanized exterior surface, nominal 40 mils thick, conforming to NEMA RN 1, Type A40.
   d. Conduit and fittings shall have a temperature rating at least equal to the operating temperature of the cable which it contains, minimum 90 degrees C. Conduit and fittings shall be free from all substances that injuriously affect any wire or cable insulation.
   e. The Manufacturer shall certify that the plastic is 100 percent virgin material and the finished product meets the specifications. All PVC conduit and fittings shall have solvent-weld connections and shall provide a water-tight joint.

2. Concrete: Comply with ACI 318 -- 3,000 psi test in 28 days - See Division 03, Section *Cast-in-Place Concrete***.**

   a. Cement: Portland Blast-Furnace Slag Cement, Type IS or equal meeting ASTM C593M Specifications and the requirements of ACI 318 and 301.
   b. Fine Aggregate: Concrete sand meeting requirements of ASTM C33.
   c. Course Aggregate: ASTM #57 crushed limestone, meeting requirements of ASTM C33.
   d. Air Entraining Admix: Complies with ASTM C260 Standard Specifications for Air Entraining Admixtures for Concrete.
   e. Water: Complies with ASTM C94 Standard Specifications for Ready-mixed Concrete.

3. Use pea gravel aggregate for void-free duct penetration.
4. Reinforcing: Deformed conforming to ASTM A615 - Grade 40**,** minimum 3/4". Provide coated rebar where exposed to earth, such as on ductbank stubouts. Bars shall be free of loose scale, rust, or other coatings that will reduce bond per Division 03, Section *Cast-in-Place Concrete*.
5. Spacers: Manufactured precast plastic assembly, base spacer, top spacers and intermediate spacers, to maintain 4-inches between conduits and completely enclosed and locked conduit assembly. Set on masonry leveling blocks prior to pour.
6. Joint Sealant: Watertight as recommended by conduit manufacturer.
7. Cable Sealing Bushings: OZ type CSB, with PVC coated discs, or equal.
8. Thruwall and Floor Seals: OZ type *FSK* or *WSK*, or equal.

9. Expansion Joints: Expansion joints shall be *Dylite*, as manufactured by Copper, Scorogord, or Dow Chemical and shall conform to ASTM D-1752, Type II.
10. Construction Joints: Construction joints shall be formed using *Jahn* Screed Joint materials as manufactured by Superior Concrete Accessories, Inc.

C. Conduit:

1. Size as indicated on the Drawings. If conduit sizes are not indicated on the Drawings, then the conduits shall be sized as follows:

   a. Four inches nominal for 600 volts or lower and for Communication
   b. Five inches nominal for voltages above 600 volts.

D. Elbows: rigid heavy wall galvanized steel with a minimum bend radius of 36 inches (915 mm).

E. Conduit Termination in Utility Holes and Buildings:

1. End Bells: Manufactured end bells of appropriate sizes at each end of conduit. When entering a new building or a new manhole, the end bells for PVC shall be a pre-manufactured system (as manufactured by Formex, or equal) with conduit seals, provision for roughing into the concrete, and water stops.
2. Bushings: Pre-manufactured groundable steel bushings of appropriate sizes where bell ends are not used. Steel bushings shall be used on all metal conduit. When entering a new building, or a new manhole, the bell ends for PVC shall be a pre-manufactured system (System as manufactured by Formex or equal) with conduit seals, provisions for roughing into the concrete pour and water stops.
3. Seals: When entering, below grade, an existing building or manhole, the concrete shall be core-drilled for the appropriate size conduit and seal. The seal shall be a mechanical interlocking assembly seal of modular synthetic rubber links properly sized to fit the pipe and tightened in place, in accordance with the manufacturer's instruction. Refer to Division 26 Section, “Common Work Results for Electrical” for additional product requirements.
4. Fire Stopping/Sealant: All cable filled conduits shall be sealed with 3M Fire Barrier 2001 Silicone RTV Foam Conduit Sealant manufactured by 3M Fire Protection Products, or approved equal.

F. Plugs: Closure plugs or caps of the same material as the conduit at the ends of the unused sections at manholes, and at building entrance openings.

G. Pull wire: Provide a polypropylene, twisted yellow, rot and mildew-resistant 3/8" minimum pull rope (2400 lbs. tensile strength) in each empty duct.

H. Grounding: Steel grounding bushings shall be grounded to the manhole or junction box ground. On steel conduit with end bells, provide an Appleton Catalog No. XJB Series or equal bonding fitting with bonding strap. Connect bonding strap to ground wire in manhole or junction box.

I. Drainage Assembly: All ducts shall drain to an open end - preferably to a manhole. Or away from the building.

2.3 ACCESSORIES

A. Duct Supports: Rigid PVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting. Spacers shall be interlocked horizontally only. Provide nylon tie-downs to hold ducts to spacers. Concrete blocks are prohibited for duct spacers.

B. End Bells: Flared, smooth-surfaced fittings of same material as conduit; if of different material, including adapter for connection to conduit.

C. Warning Tapes:

1. Refer to Division 26 Section, “Electrical Identification” for product requirements.

2.4 TEST PITS

A. Provide test pits to locate all utilities and structures. Provide test pits as necessary to determine actual locations and profiles of obstructions to proposed new work.

B. Verify existing utilities, locations, and inverts and points of connection.

PART 3 - EXECUTION

3.1 LOCATION AND LAYOUT:

A. Indicated plans and profiles - approximate, based on field information and available as-built plans.

B. Actual locations and profiles - based on test pits to locate all shown utilities and structures. Test pits at beginning, center, end, and at all ductbank bends and utility crossings.

C. Plan and profile adjustments - All provided at no additional cost to Owner, subject to approval.

D. Examine site to receive ducts and handholes for compliance with installation tolerances and other conditions affecting performance of the underground ducts and manholes. Do not proceed with installation until unsatisfactory conditions have been corrected.

E. Connection to existing duct banks - Contractor to verify location and inverts of existing duct banks, at points of connection.

3.2 INSTALLATION:

A. In accordance with NEMA publication TC-2 and manufacturer's recommendations.

B. Top of envelope below grade - Minimum as follows: as indicated on the Drawings minimum (600 volts and below).

C. Concrete envelope - 3 inches minimum beyond surface of any conduit, minimum 2 inches between conduits. Top of ductbank shall be crowned to prevent puddling of water.

D. Seal and Thru Wall Fittings - At entrances to buildings for watertight construction.

E. Sweeps and bends - Minimum 25 foot radius (except at conduit risers) unless otherwise approved to accomplish changes in direction of runs either horizontally or vertically. Double offsets: Minimum 100 foot radius. Sweep bends may be made up of one or more curved or straight sections or combinations thereof. Manufactured bends shall have a minimum radius of 36 inches.

F. Mandrel conduits - Mandrel 12 inch long, 1/4 inch less than conduit I.D. Draw a testing mandrel through each duct.

G. Clean conduits - After mandrel, with stiff brush, leave no particles or debris. Immediately install end plugs after cleaning.

H. Pull Line - Provide 100-pound-tested nylon pull line in all conduits, including spares. Provide 3 feet of slack at each end of conduit and tag.

I. Stagger vertical conduit joints - minimum 6 inches. All joints shall have couplings installed.

J. Reinforcing steel - Provide reinforcing steel the entire length of the duct system. Provide four #4 bars, one in each corner minimum, overlap the joints 12-inches, and tie them into the respective utility, vaults, and buildings, etc. Rebar shall not be installed less than 2-inches from sides of any duct.

3.3 EXCAVATION, BACKFILLING, COMPACTING AND SITE PREPARATION:

A. Provide all excavating and backfilling and site preparation necessary to install underground ductbanks, cables, etc., included in this section of the work. Excavation and backfill shall be performed in accordance with the requirements of the Division 26 Section, “Common Work Results for Electrical”.

B. Install forms on sides of the ductbank if the trench is not of the proper firmness to prevent cave-in. Provide all required excavating, shoring, sheeting, bracing, and backfilling.

C. The bottom of the trench shall be undisturbed earth. If the trench bottom is too low for proper grade, fill to the proper level with sand and mechanically compact it. Cut trenches neatly and uniformly.

D. Each excavated section from manhole to manhole and from manhole to building shall be completely excavated and graded before any duct is laid in that section.

E. Provide underground detectable warning tape 12-inches below finished grade over all ductbanks.

F. Excavation and Backfill: Conform to Division 02, Section *Earthwork*, but do not use heavy-duty, hydraulic-operated compaction equipment.

G. After excavation of the trench, stakes shall be driven in the bottom of the trench at four-foot intervals to establish the grade and route of the duct bank.

H. Pitch the trenches uniformly towards manholes or both ways from high points between manholes for the required duct line drainage. Avoid pitching ducts towards buildings wherever possible.

I. The walls of the trench may be used to form the side walls of the duct bank provided that the soil is self-supporting and that concrete envelope can be poured without soil inclusions. Forms are required where the soil is not self-supporting.

J. After the concrete-encased duct has sufficiently cured, the trench shall be backfilled to grade with earth.

K. Restore surface features at areas disturbed by excavation, and reestablish original grades except as otherwise indicated. Replace removed sod as soon as possible after backfilling is completed. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, or mulching. Perform according to Division 02.

L. Remove pavements, sidewalks, curbs, and gutters where necessitated by construction of ducts.

M. Surplus earth from the trenches, after compacting, shall be removed and disposed of.

3.4 CUTTING AND PATCHING:

A. Provide all cutting and patching necessary for the installation of the electrical work. Any damage done to the work already in place by reason of this work shall be repaired expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.

B. Existing Obstructions: Where drawings indicate that underground conduits are to cross under existing roadways, walks or other similar paved areas, steel conduits will be driven under such areas in lieu of installing the conduits in trenches as specified above. After installation of conduit by either method, all existing paved or grass areas which have been disturbed in any way shall be restored to their original conditions. Where drawings indicate spare conduits under existing roadways, walks, and other similar paved areas, all ends of conduits shall be capped five feet beyond the pavement and adequately protected from mechanical damage. The ends of these conduits shall be marked by the placement of concrete monuments. Minimum size shall be 6 inches in diameter by 18 inches long set flush in ground with "S/C" indented in top to signify spare conduit.

C. Re-use of Existing Utility Holes: The Contractor shall appropriately dowel new ductbank to existing manholes. Provide expansion joint material between raceway easement and the outer wall of the existing manhole. Waterproof the penetrations.

D. Connections to Existing Utility Holes: For duct bank connections to existing structures, break the structure wall out to the dimensions required and preserve steel in the structure wall. Cut steel and bend out to tie into the reinforcing of the duct bank envelope. Chip the perimeter surface of the duct bank opening to form a key or flared surface, providing a positive connection with the duct bank envelope.

E. Connections to Existing Ducts: Where connections to existing duct banks are indicated, excavate the banks to the maximum depth necessary. Cut off the banks and remove loose concrete from the conduits before the new utility hole is installed.

F. Conduit Protection at Penetrations: Galvanized conduits which penetrate concrete shall be PVC-coated and shall extend at least 2 inches within the concrete to the first coupling or fitting outside the concrete.

G. Provide all cutting and patching necessary for the installation of the ductbank work. Any damage done to the work already in place by reason of this work shall be repaired at the Contractor's expense by a qualified mechanic experienced in such work. Patching shall be uniform in appearance and shall match with the surrounding surface.

H. Patching shall be done in accordance with the requirements of Division 02 for the appropriate disturbed surface materials.

I. Work with extreme care near existing ducts, conduits, cables, and other utilities to avoid damaging them.

3.5 PLACEMENT OF CONDUIT

A. Within five (5) feet of each existing building wall or utility hole penetration, install heavy wall galvanized steel conduit within the concrete envelope to provide protection against vertical shearing.

B. Core drill all existing walls, and waterproof per Division 26 using an assembly of rubber links of mechanical seal of the proper size for the pipe and tighten in place, in accordance with the manufacturer's instruction, after the new conduit is installed.

C. Install spacers as recommended by the conduit manufacturer and requirements stated above, but not to exceed a maximum of four feet on center for PVC conduit and eight feet on center for steel conduit. Bottom spacers shall rest on 8-inch x 16-inch x 2-inch minimum concrete pads to prevent them from sinking into the ground and reducing the bottom concrete cover. Stagger conduit joints in concrete encasement 6 inches minimum horizontally.

1. Spacer assembly shall consist of base spacers, intermediate spacers, and top spacers to provide a completely enclosed and locked conduit assembly.
2. Before placing concrete, anchor duct bank assemblies to prevent the assemblies from floating during concrete placement. Anchoring shall be done by driving

reinforcing rods adjacent to every other duct spacer assembly and attaching the rod to the spacer assembly.

3. Set on masonry leveling blocks prior to pour.

D. Pitch conduit properly for drainage to manhole or pull box and to prevent low pockets or irregular dips between conduit ends. Minimum pitch to be 4 inches per 100 feet.

E. Provide accurate locations of conduit in utility hole.

F. Depending on encasement necessary for duct formation, place conduits on spacers. The minimum encasement thickness 1-1/2-inches on all sides.

G. Lay conduits using spacers to provide tier spacing.

H. Make tight conduit joints by complying with recommendations of conduit manufacturer, using coupling jointing compound or PVC primer and solvent cement. All joints in conduits and fittings shall be made up tight and shall be watertight. All threaded portions of steel conduits that are not to be encased in concrete and adjoining ends of conduits, couplings and fittings, shall be heavily coated with asphaltum after installation. All connections between conduits of different types shall be made in an approved manner, using adapters of other materials and methods recommended for the purpose by the conduit manufacturers.

I. Provide not more than one 90-degree bend or equivalent between pull points for primary conduit and two 90-degree bends or equivalent for signal conduit.

J. In ductbanks with both primary and signal conduit, primary conduit shall be straight and the signal conduit shall contain bends as necessary to accommodate the primary duct. Any offsets or bends shall be made in steel conduit. PVC conduit may only be used in straight lengths.

K. Provide flush bell ends on duct at utility holes. When entering a new building or a new manhole, the bell ends for PVC shall be a pre-manufactured system (system as manufactured by Formex or equal) with conduit seals and provisions for roughing into the concrete.

L. Provide insulated, grounding bushings on duct ends in equipment enclosures.

M. Plug or cap empty conduits. Provide standard manufactured plugs.

N. Seal all spare ducts and conduits, at all new and existing building entrances and at outdoor terminations at equipment pedestals with a suitable compound to prevent the entrance of moisture and gases.

O. After ducts are in place and before the concrete is poured, the installation shall be inspected by the Engineer. Notify the Engineer at least two days before the time of inspection.

P. Clear conduit by rod and pull an approved test mandrel from structure to structure or from structure to the conduit termination.

Q. Leave nylon or polyester pull line in each conduit, tagged to identify the conduit's point of origin, contents and final destination.

R. Conduit Couplings: Conduit couplings shall be staggered so that couplings on adjacent conduits will not lie in the same transverse plane. End bells shall be spaced approximately 9 inches center to center at face of manhole wall for 4-inch conduits and proportionately spaced for other sizes. The change from regular conduit spacing to end bell spacing shall start 10 feet from the face of the manhole wall and shall be made in such a way that the slope of any conduit will not be less than that of the main bank and no trap will be formed. New conduit entrances into existing manholes and building walls shall enter at the most desirable locations consistent with grading requirements and existing entrance and shall be waterproofed in a satisfactory manner.

S. Bends: Conduit generally shall be straight between manholes or upturned elbows. Where bends are unavoidable in non-metallic conduits, they may be made by assembling couplings at a slight angle, provided the watertight seals are not broken and the resulting radius is not less than 100 feet. For radii less than 100 feet, 5-degree angle couplings or 5-degree factory-made bend sections shall be used.

1. Install top of duct bank minimum 30 inches below finished grade.
2. Terminate conduit in end bell at manhole entries.
3. Provide minimum 3-inch concrete cover at bottom, top, and sides of duct bank.

T. Multiple conduit: Install multiple conduit as follows:

1. Multiple conduit runs, direct burial or in duct bank, shall be supported on preformed, non-metallic separators. Spacing between exterior surfaces of conduits generally shall be not less than the following:

    a. Three (3) inches between telephone conduits.
    b. Three (3) inches between conduits containing cables operating at not over 600 volts.
    c. Six (6) inches between a telephone conduit and any power conduit in the same envelope
    d. Three (3) inches between conduits containing cables operating at over 600 volts.
    e. Spacing between separators shall be close enough to prevent sagging of conduits and breaking of couplings and watertight seals. Separators shall also be spaced to keep deformation of conduit at the separators to 0.10-inch or less. Separators shall be secured with cords where necessary and no tie wires, reinforcing rods or other metallic materials shall be placed around the conduits, either individually or in groups, in such a manner as to form a magnetic loop.

2. Multiple conduit runs shall be arranged substantially as shown on the drawings, but minor changes in location or cross sectional arrangement shall be made as necessary to avoid obstructions. Where conduit runs cannot be installed substantially as shown because of conditions not discoverable prior to digging of trenches, the condition shall be referred for instructions before further work is done. All underground conduit work shall be coordinated with other outside service work. Existing outside services shall be maintained in operation unless directed otherwise.

3.6 CONCRETE WORK

A. Unless otherwise indicated, all concrete work for electrical manholes, ductbanks, etc., shall be provided under this section of the work. All concrete work shall conform to the requirements as hereinbefore specified in Division 03. All concrete shall be minimum 3,000 psi test at 28 days. Concrete for ductwork shall be Class B, 470 lb. (5 sacks) of Portland cement per cubic yard.

B. Supervise the placement of concrete in the ductbank.

C. Complete entire section of conduit from utility hole to manhole or from manhole utility pole to building to building before encasement by concrete. The entire conduit system shall be tied together with wire and anchored to the bottom of the trench to prevent any movement or floating while pouring concrete.

D. Place concrete as specified in Section. Top of concrete envelopes shall be not less than 30 inches below grade.

E. Provide minimum of 3-inches (76mm) of concrete cover over conduit at the top, bottom, and sides of the duct bank. Provide crowned top on the concrete to prevent water accumulation. At poured manholes, tie duct and manhole reinforcing steel together to provide a permanent connection.

F. Place concrete continuously from manhole to manhole to building without interruption.

G. Extend concrete envelope to finish floor grade or interior wall surface in buildings at finish pad grade at equipment. Maintain moisture seal.

H. Conduits in completed ductbanks shall be straight to within 1/4 inch per 100 feet in both vertical and horizontal directions.

I. Pull solid mandrels and swabs (diameter 1/4 inch smaller than conduit) through each conduit in completed ductbank before installing cables.

J. Concrete-Encased Nonmetallic Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting.

    a. Provide spacers staggered at least 6 inches vertically along the length of the duct run to eliminate the potential for a weak vertical shear plane in concrete encasements.
    b. Provide a minimum of four spacers per 20-foot interval (5 feet maximum) along the length of the duct run.

2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven

agitating equipment unless specifically designed for duct bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. When more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (18mm) reinforcing rod dowels extending 18 inches (450 mm) into the concrete on both sides of joint near the corners of the envelope.

3. Reinforcing: Provide reinforcing steel bars at the top and bottom of each concrete envelope as shown on Drawings and at the present and indicated future locations, including but not limited to the following:

    a. Crossing fill or loose soil (4 feet beyond the exterior limits on each side).
    b. Crossing other utilities (8 feet beyond the exterior limits on each side).
    c. Entering buildings, manholes, vaults, etc. (20 feet beyond).
    d. Crossing vehicle roadways and parking areas (underneath and 20 feet beyond the exterior limits on each side).
    e. Rebar shall not be installed less than 2-inches from the sides of any duct.
    f. Under all pavement (6 feet beyond edge of pavement).
    g. Crossing soils and rock where the bottom of the trench is not undisturbed soil or the bearing is less than 3,000 psf, then the entire distance such conditions exist, plus 10 feet either side of these conditions.

4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions. Otherwise, use forms.
5. Minimum Clearances Between Ducts: Three inches (75 mm) between ducts and exterior envelope wall, 3 inches (75 mm) between ducts for like services, and 6 inches (150 mm) between power and signal ducts. Provide plastic spacers to maintain clearances.
6. Depth: Except as otherwise indicated, install top of duct bank at least 30 inches (750 mm) below finished grade in nontraffic areas for 600 volts and below. Install at least 30 inches (750 mm) below finished grade in vehicular traffic areas for 600 volts and above.

K. Partial Pouring: Each run of envelope between manholes shall be poured in one continuous operation. Where more than one pour is necessary, each pour shall terminate in a vertical plane, and 3/4-inch reinforcing rod dowel extending 18 inches into the concrete on each side of the joint shall be provided. The number and locations of dowels shall be as approved. Partial pours shall not terminate in horizontal or angular planes.

L. Extensive Disturbed Earth: Where an envelope is installed over an extensive area of disturbed earth, such as that within the periphery of the building, a separate 3,000 psi concrete base, satisfactory, shall be provided to ensure stability of the conduits during installation. The base shall be allowed to set before the conduit bank is installed.

M. Obstructions Below Grade: Where an envelope is installed over disturbed earth, across other conduits or pipe lines or under roads or driveways, it shall be reinforced. Reinforcement shall also be provided where envelopes connect to manhole and building walls, to prevent shearing of the joints. Where envelopes are terminated for future extension, dowels shall be provided as specified above for joints between pours. Reinforcement, generally, shall consist of 3/4-inch rods located in a single layer 1-1/2 inches above the bottom of the envelope. Outside rods shall be located 1-1/2 inches in from the outside edges

of the envelopes and an intermediate rod shall be placed in the center of each space between conduits in the lowest row. Provide No. 4 steel reinforcing bars in top of envelope under paved areas. Additional reinforcement shall be furnished as directed following an inspection of the trench.

N. Stub-Ups: Use rigid steel conduit for stub-ups to equipment. For equipment mounted on outdoor concrete pads, extend steel conduit a minimum of 5 feet (1.5m) from the edge of the pad and 5 feet outside of the building foundation. Install insulated grounding bushings on the terminations. Couple steel conduits to the ducts with adapters designed for the purpose and then encase coupling with 3 inches (75 mm) of concrete. Provide insulated grounding bushings on the terminations.

O. Above-Grade Conduit:

1. All exposed conduit rising more than one foot (1') above the adjacent grade shall be rigid steel conduit, full weight, pipe size, finished inside and outside by a hot-dipped galvanized method. Conduit shall have threaded-type couplings and fittings with insulated end bushing. Rigid steel conduit shall extend a minimum of eighteen inches (18-inches) below grade before transition to PVC conduit.
2. Provide galvanized or cadmium-plated nails, screws, clips, or other means of securely anchoring conduit to buildings or other structures as required for a complete installation. Adequate provisions shall be taken to prevent dielectric action between dissimilar metals.

P. Sealing: Provide temporary closure at terminations of ducts that are wired under this project. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15 psi (1.03 Mpa) hydrostatic pressure.

Q. Duct Entrances to Manholes and Handholes: Space end bells approximately 10 inches (250 mm) on center for 5-inch (125 mm) ducts and varied proportionately for other duct sizes. Change from regular spacing to end-bell spacing 10 feet (3m) from the end bell without reducing duct line slope and without forming a trap in the line. Grout end bells into manhole walls from both sides to provide watertight entrances. Provide expansion joint material between duct and handhole.

1. Duct bank envelopes connecting to underground structures shall be flared to have an enlarged cross-section at the manhole entrance to provide additional shear strength. Dimensions of the flared cross-section shall be larger than the corresponding manhole opening dimensions by no less than 12 inches in each direction. Perimeter of the cut bank opening in the underground structure shall be flared toward the inside or keyed to provide a positive interlock between the duct bank and the wall of the structure. Use vibrators when this portion of the encasement is placed to assure a seal between the envelope and the wall of the structure.

R. Building Entrances: Transition from underground duct to conduit 10 feet (3m) minimum outside the building wall. Use fittings manufactured for the purpose. Follow appropriate installation instructions below.

1. Concrete-Encased Ducts: Install reinforcing in ductbanks passing through disturbed earth near buildings and other excavations. Coordinate ductbank with structural

design to support ductbank at wall without reducing structural or watertight integrity of building wall.

2. Waterproofed Wall and Floor Entrances: Install a watertight entrance-sealing device with the sealing gland assembly on the inside. Anchor device into masonry construction with 1 or more integral flanges. Secure membrane waterproofing of the device to make permanently watertight.

S. Mandrelling: After concrete envelopes have set, all conduits shall be mandrelled to ensure smooth interior surfaces free from burrs or obstructions that might damage the conductor Insulation or sheaths.

3.7 CONDUIT AND DUCT INSTALLATION

A. Install nonmetallic conduit and duct as indicated according to Manufacturer's written instructions.

B. Slope: Pitch ducts a minimum of 3 inches per 100 feet to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two (2) manholes to drain in both directions. Trenches shall be evenly graded so that conduits will have a uniform rate of fall of not less than 3 inches per 100 feet and will be free from either horizontal or vertical waves. Unless otherwise specified, each conduit shall slope uniformly from one manhole to the next or from a high point between manholes. Low points between manholes or between upturned elbows, shall be avoided wherever possible. Where it is not possible to avoid a trap or low point in a conduit which has no concrete envelope, provide a 1/2-inch hole drilled in the bottom of the conduit at the low point and a crushed stone sump of suitable volume below the conduit. If possible, install the sump above the high water table elevation for the particular location. Otherwise, provide special means to prevent the accumulation of water within the conduit.

C. Curves and Bends: Use manufactured elbows for stub-ups at equipment and at building entrances. Use manufactured long sweep bends with a minimum radius of 50 feet (15 m) both horizontally and vertically at other locations.

D. Make joints in ducts and fittings watertight according to manufacturer's instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.

E. Installation of warning tapes: After lacing a minimum of 12 –inches or a maximum of 18 inches of backfill over the ducts, place the appropriate warning tapes above and parallel to the centerline of the duct for the entire length of the duct trench.

F. Provided pull rope and measuring tape shall be installed at the time the mandrel is pulled through each conduit. Record the wall-to-wall measurements and the size of mandrel used at this time. Provide this documentation to the Project Engineer on the following working day. After acceptance of these documents, the Contractor shall remove the measuring tape, leaving only the pull rope in the conduits.

G. All work and materials covered by these Specifications shall be subject to inspection at times by the Owner's designated representative. Any work concealed before it has been inspected by the Owner's designated representative shall be re-opened or uncovered and any required

modification made to that portion of the work. All trenches shall be opened from manhole to manhole or manhole to building prior to laying conduit in that trench. Exceptions (such as street crossings) will be approved prior to excavation on a case-by-case basis by the Owner at a regular project meeting. These sites shall be inspected by the Owner's representative during excavation, installation, backfill, restoration, and cleanup.

H. Separation distance from other buried utilities as follows:

1. Insulated Steam: 24-inches.
2. Un-insulated Steam: 48-inches.
3. All others: 18-inches.

3.8 REUSE OF EXISTING DUCTBANKS:

A. Where new cables are to be installed in existing ductbanks and conduit , mandrel and brush clean each duct prior to installation of new cable. Mandrel and brush procedures shall be as specified for new conduit and ductbanks. If any duct is found to be collapsed, or deformed, it shall be brought to the attention of the Engineer immediately.

3.9 DIRECT BURIED DUCT CONDUIT:

A. Provide where indicated direct-buried electrical circuits utilizing either PVC Schedule 40 or PVC-coated rigid galvanized steel conduit, as indicated. Conduit shall be as specified in Section 260533. Burial depth shall be as follows:

1. Below paved roads (PVC and RGS): 30-inches below bottom of paving.
2. Under non-vehicle concrete (PVC and RGS): 30-inches below bottom of paving.
3. Other areas (PVC): 24-inches.
4. Other areas (RGS): 24-inches.

B. Minimum separation from other utilities shall be the same as for ductbanks, specified previously in the section.

C. Where feasible, and where indicated, install direct-buried lines parallel, but separated from other utility lines. Group several direct-buried conduits in a common trench where running in the same direction, or to/from the same source. All direct-buried conduits shall have yellow plastic warning tape buried midway between the conduit and finished grade. Tape shall be the same as used for ductbanks.

D. Where direct-buried conduits penetrate walls or floor slabs, seal all spaces around conduit and fittings. Provide through-wall fittings on all wall penetrations.

E. Where an underground conduit, without a concrete envelope, enters the building through a non-waterproofed wall or floor, provide a sleeve made of Schedule 40 galvanized pipe. The space between the conduit and the sleeve shall be filled with a suitable plastic expansible compound or an oakum and lead joint on each side of the wall or floor in such a manner as to prevent entrance of moisture. A watertight entrance sealing device hereinbefore specified will be acceptable in lieu of the sleeve.

3.10 RECORD DOCUMENTS

A. Provide record set data of the actual elevation of the top of each end of each raceway or ductbank at the midpoint, at no more than 100 foot intervals, where changes in elevation are less than 2 feet between data points, or 10 foot intervals when the elevation between intervals is different by 2 feet or more between data points.

B. Provide record drawings indicating actual locations of all installed ductbanks and manholes including elevations. The record drawing shall indicate location, elevation, and type of service for all utilities crossed by new ductbank.

C. Cable Records: The Contractor shall provide a complete listing of all cables installed in each conduit and ductbank, along with all cable splice locations.

3.11 FIELD QUALITY CONTROL

A. Field inspection and testing shall be performed in the presence of the Engineer.

B. Backfilling shall not be done until the concrete has cured for at least three calendar days.

C. Exposed surfaces of concrete shall be kept wet (damp) throughout the curing period.

D. Upon completion of the duct bank installation, a standard flexible mandrel shall be pulled through each duct to loosen particles of earth, sand, or foreign material left in the line. The mandrel shall be not less than 12 inches long, and shall have a diameter 1/4-inch less than the inside diameter of the duct. A brush with stiff bristles shall then be pulled through each duct to remove the loosened particles. The diameter of the brush shall be the same as, or slightly larger than, the diameter of the duct.

E. Seal the ducts and conduits at building entrances, and at outdoor terminations for equipment, with a suitable non-hardening compound to prevent the entrance of moisture and gases.

END OF SECTION

DIVISION 26
SECTION 260553
ELECTRICAL IDENTIFICATION
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SECTION 260553 - ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes electrical identification materials and devices required to comply with ANSI C2, NFPA 70, OSHA standards, and authorities having jurisdiction.

B. This section includes labeling of all terminations and related subsystems; including, but not limited to, nameplates, stenciling, wire and cable markers, labeling and identification of cables, equipment and other products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Schedule of Nomenclature: An index of electrical equipment and system components used in identification signs and labels. Provide a schedule of nameplates and stenciling.

C. Samples: Prior to installation, submit samples for each type of label and sign to illustrate color, lettering style, and graphic features of identification products. These samples shall include examples of the lettering to be used. Samples shall be mounted on 8-1/2-inch x 11-inch sheets annotated, explaining their proposed use.

D. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Comply with ANSI A13.1 and NFPA 70 for color-coding.

D. Comply with applicable EIA/TIA Standards.

E. Comply with OSHA Standards.

1.5 DEFINITIONS

A. Emergency systems include, but are not limited to fire alarm systems, exit sign circuits, emergency lighting circuits, etc.

PART 2 - PRODUCTS

2.1 RACEWAY AND CABLE LABELS

A. Comply with ANSI A13.1, Table 3, for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

1. Color: Black letters on orange field.
2. Legend: Indicates voltage and service.

B. Adhesive Labels: Preprinted, flexible, self-adhesive vinyl with legend, overlaminated with a clear, weather- and chemical-resistant coating.

C. Pretensioned, Wraparound Plastic Sleeves: Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the line it identifies and arranged to stay in place by pretensioned gripping action when placed in position.

D. Colored Adhesive Tape: Self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide (0.08 mm thick by 25 to 51 mm wide), in appropriate colors for system voltage and phase.

E. Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.

F. Aluminum, Wraparound Marker Bands: Bands cut from 0.014-inch- (0.4-mm-) thick aluminum sheet, with stamped or embossed legend, and fitted with slots or ears for permanently securing around wire or cable jacket or around groups of conductors.

G. Plasticized Card-Stock Tags: Vinyl cloth with preprinted and field-printed legends. Orange background, unless otherwise indicated, with eyelet for fastener.

H. Aluminum-Faced, Card-Stock Tags: Weather-resistant, 18-point minimum card stock faced on both sides with embossable aluminum sheet, 0.002 inch (0.05 mm) thick, laminated with moisture-resistant acrylic adhesive, punched for fasteners, and preprinted with legends to suit each application.

I. Brass or Aluminum Tags: 2 by 2 by 0.05-inch (51 by 51 by 1.3-mm) metal tags with stamped legend, punched for fastener.

2.2 NAMEPLATES AND SIGNS

A. Safety Signs: Comply with CFR, Title 29, Chapter XVII, Part 1910.145.

B. Engraved Plastic Nameplates and Signs: Engraving stock, melamine 3-layer plastic laminate, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Use colors prescribed by ANSI A13.1, NFPA 70 and these specifications.

1. Engraved legend with white letters on black background.
2. Backed with adhesive material appropriate for installation application, i.e. surface material, temperature, etc…

C. Baked-Enamel Signs for Interior Use: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

D. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for the application. 1/4-inch (6.4-mm) grommets in corners for mounting.

E. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32, stainless-steel machine screws with nuts and flat and lock washers.

2.3 UNDERGROUND LINE WARNING TAPE

A. Non-biodegradable, polyethylene tape, 8 mil thick and a minimum of 6 inches wide with detectable metallic foil. Provide warning labels on 3 foot centers and be colored as follows:

1. Electrical ducts, piping or cable (600V and below) - Yellow tape with black printed labeling: CAUTION-BURIED ELECTRICAL LINE BELOW.
2. Electrical ducts, piping or cable (above 600V) - Red tape with black printed labeling: CAUTION-HIGH VOLTAGE CABLE BURIED BELOW.
3. Telephone conduits or cable - Orange tape with black printed labeling: CAUTION-BURIED TELEPHONE LINE BELOW.

4. Fiber Optic conduits or cable - Orange tape with black printed labeling: CAUTION-BURIED FIBER OPTIC LINE BELOW.
5. Cable TV(CATV) conduits or cable - Orange tape with black printed labeling: CAUTION-BURIED CABLE TV LINE BELOW.

B. Where two (2) or more services share a common ductbank, i.e. telephone and fiber optic, warning tape for each service shall be installed above each service's respective conduit(s).

C. Bury marker tape 12-inches below grade above every ductbank and buried conduit.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.3 kg) minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: According to color-coding.

B. Paint: Formulated for the type of surface and intended use.

1. Primer for Galvanized Metal: Single-component acrylic vehicle formulated for galvanized surfaces.
2. Primer for Concrete Masonry Units: Heavy-duty-resin block filler.
3. Primer for Concrete: Clear, alkali-resistant, binder-type sealer.
4. Enamel: Silicone-alkyd or alkyd urethane as recommended by primer manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. Where mixed voltages are used in one building (e.g., 480 volts, 208 volts), each switch, junction box, equipment, etc., on each system must be labeled for voltage in addition to other requirements listed herein.
2. All branch circuit and power panels must be identified with the same symbol used in the circuit directory in the main distribution center.
3. Before attaching labels, clean all surfaces with the label manufacturer's recommended cleaning agent.
4. Install all labels firmly, as recommended by the label manufacturer.
5. Labels attached to receptacle and switch data or Communication patch panels and faceplates shall be installed plumb and neatly on all equipment.
6. Install nameplates parallel to equipment lines.
7. Secure nameplates to equipment fronts.
8. Secure nameplates to inside of flush-mounted panelboards in finished locations.

9. Embossed tape will not be permitted for any application.
10. Stenciling may only be used on equipment fronts in unfinished areas or in areas designated by the Architect/Engineer.
11. Labels: All labels shall be permanent and be machine-generated. NO HANDWRITTEN OR NON-PERMANENT LABELS SHALL BE ALLOWED.
12. Label size shall be appropriate for the conductor cable size(s) and outlet faceplate layout. All labels to be used shall be self-laminating, white/transparent vinyl and be wrapped around the cable sheath**.** Flag type labels are not allowed. The labels shall be of adequate size to accommodate the circumference of the cable being labeled and properly self-laminated over the full extent of the printed area of the label.

B. Panelboard Directories: Typed directories for panelboards must be covered with clear plastic and have a metal frame. Room numbers on directories shall be Owner's numbers, not plan numbers, unless Owner so specifies.

1. Panelboards shall be equipped with equipment nameplates as specified in paragraph “Equipment Identifications Labels” in Part 3 of this Section.
2. Panelboards shall have an accurate typed index indicating exactly what each added branch serves.
3. The Contractor shall provide up to date directories in panelboards indicating all deletions and additions, and to note the date of all changes on the directory.
4. The directory shall reflect the exact circuit designations**.** Directories indicating the reference room numbers on the contract drawings or in the panelboard schedule shall not be acceptable.
5. If at anytime after occupancy the directory is found to be incorrect due to negligence by the installer, then the Contractor shall trace out circuits, and correct the directory at no additional cost to the Owner.

C. Miscellaneous Identification:

1. Individual circuit breakers, switches, and motor starters in panelboards, switchboards, and motor control centers: 1/4-inch (6 mm); identify circuit and load served, including location.
2. Individual circuit breakers, enclosed switches, and motor starters: 1/4-inch (6 mm); identify load served.
3. Junction boxes: 1/2-inch (13 mm); identify system source(s) and load(s) served.

D. Identification Materials and Devices: Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

E. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

F. Sequence of Work: If identification is applied to surfaces that require finish, install identification after completing finish work.

G. Self-Adhesive Identification Products: Clean surfaces before applying.

H. Circuits with More Than 600 V: Identify raceway and cable with *DANGER--HIGH VOLTAGE* in black letters 2 inches (51 mm) high, stenciled with paint at 10-foot (3-m) intervals over a continuous, painted orange background. Identify the following:

1. Entire floor area directly above conduits running beneath and within 12 inches (305 mm) of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
2. Wall surfaces directly external to conduits concealed within wall.
3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in the building, or concealed above suspended ceilings.
4. Entire surface of exposed conduits.

I. Install painted identification according to manufacturer's written instructions and as follows:

1. Clean surfaces of dust, loose material, and oily films before painting.
2. Prime surfaces using type of primer specified for surface.
3. Apply one intermediate and one finish coat of enamel.

J. Color Code Banding and Painting of Raceways, Boxes, and Cables: Band all exposed and concealed accessible raceways, pull boxes, and junction boxes of the systems listed below:

1. Bands: Pre-tensioned, wraparound plastic sleeves; colored adhesive tape; or a combination of both. Make each color band 2 inches (51 mm) wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.
2. Band Locations: At changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.
3. Junction boxes, pull boxes, and their covers shall be distinctively painted to identify their service.
4. Apply the following colors to the systems listed below:

    a. Fire Alarm System: Red.
    b. Fire-Suppression Supervisory and Control System: Red and yellow.
    c. Combined Fire Alarm and Security System: Red and blue.
    d. Security System: Blue.
    e. CCTV System: Green and yellow.
    f. Mechanical and Electrical Supervisory System: Green and blue.
    g. Telecommunication System: Green.
    h. CATV System: Violet.
    i. Computer Data: Blue.
    j. 120/208 V (or 120/240 V) Power and Lighting System: Yellow.
    k. 480/277 V Power and Lighting System: Black.
    l. Standby/Emergency Power System: Orange.
    m. Any other system, with system type (such as *Sound System*) marked on covers in black letters with white backgrounds.

K. Caution Labels for Indoor Boxes and Enclosures for Power and Lighting: Install pressure-sensitive, self-adhesive labels identifying system voltage with black letters on orange

background. Install on exterior of door or cover. Install label on inside face of door or cover in finished spaces.

L. Circuit Identification Labels on Boxes: Install labels externally.

1. Exposed Boxes: Pressure-sensitive, self-adhesive plastic label on cover.
2. Concealed Boxes: Plasticized card-stock tags.
3. Labeling Legend: Permanent, waterproof listing of panel and circuit number or equivalent.

M. Paths of Underground Electrical Lines: During trench backfilling, for exterior underground power, control, signal, and communication lines, install continuous underground line warning tape located directly above line at 12 inches (150 to 200 mm) below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm) overall, use a single line marker. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

N. Secondary Service, Feeder, and Branch-Circuit Conductors: Color-code throughout the secondary electrical system. The following color code convention(s) shall be used except where existing systems have established another color code convention.

1. Color-code 208 /120-V system as follows:

   a. Phase A: Black.
   b. Phase B: Red.
   c. Phase C: Blue.
   d. Neutral: White.
   e. Ground: Green.

2. Color-code 480/277-V system as follows:

   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.
   d. Neutral: White with a colored stripe or gray.
   e. Ground: Green.

3. Factory apply color the entire length of conductors, except the following field-applied, color-coding methods may be used instead of factory-color-coded wire for sizes larger than No. 10 AWG:

   a. Colored, pressure-sensitive plastic tape in half-lapped turns for a 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. Use 1-inch- (25-mm-) wide tape in colors specified. Adjust tape bands to avoid obscuring cable identification markings.
   b. Colored cable ties applied in groups of three ties of specified color to each wire at each terminal or splice point starting 3 inches (76 mm) from the terminal and spaced 3 inches (76 mm) apart. Apply with a special tool or pliers, tighten to a snug fit, and cut off excess length.

O. Power-Circuit and Control Wire Identification: Metal tags or aluminum, wraparound marker bands for each conductor, cables, feeders, and power circuits in vaults, panelboard gutters, outlet boxes, junction boxes, pullboxes, junction boxes, manholes, switchboard rooms, and at load connections. Identify with branch circuit or feeder number for power and lighting circuits and with control wire number as indicated on equipment manufacturer's shop drawings for control wiring.

1. Legend: 1/4-inch- (6.4-mm-) steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
2. Tag Fasteners: Nylon cable ties.
3. Band Fasteners: Integral ears.

P. Apply identification to conductors as follows:

1. Conductors to be Extended in the Future: Indicate source and circuit numbers.
2. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color-coding to identify circuits' voltage and phase.
3. Multiple Control and Communication Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color-coding, or cable marking tape.

Q. Apply warning, caution, and instruction signs as follows:

1. Warnings, Cautions, and Instructions: Install to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
2. Emergency Operation: Install engraved laminated signs with white legend on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

R. Equipment Identification Labels: Engraved plastic laminate with white lettering on black background. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Unless otherwise noted, labels/nameplates shall identify equipment designation(s), voltage rating, and source (including source locations). Labels for disconnect switches, motor starters, etc…, shall indicate the designation of the load served as the “equipment designation”. In general, labels requiring one or two lines of text shall be 1-1/2 inches high. Labels requiring three lines of text shall be 2 inches high. The first line of text, which shall indicate equipment designation/load served, shall utilize ½ inch high lettering. Remaining lines of text, which shall indicate voltage ratings and source information shall utilize ¼ inch high lettering. Refer to the Drawings for labeling examples. Apply labels to each unit of the following categories of equipment using mechanical fasteners:

1. Panelboards.
2. Electrical Switchboards.

3. Transformers.
4. Disconnect Switches.
5. Enclosed Circuit Breakers.
6. Motor Starters.
7. Push-Button Stations.
8. Contactors.
9. Electrical Cabinets and Enclosures.
10. Control Devices.
11. Fire Alarm Master Station or Control Panel.
12. Security-Monitoring Master Station or Control Panel.
13. Access Doors and Panels for Concealed Electrical Items.

S. Conduits Containing Electrical Feeders:

1. All conduits containing electrical feeders shall be identified with W.H. Brady B-500 vinyl cloth pipe markers or equivalent. Systems shall be identified as follows:
   a. Labels shall be applied whenever a conduit enters or leaves a switchboard, panelboard, or a junction or pull box, and at each side of penetrations of walls or floors.
   b. Apply Y-35 series individual numbers and letters to indicate feeder number followed by feeder voltage.
   c. At each end of the above series of markers provide a pipe banding tape around the conduit. Refer to paragraph "Color Code Banding and Painting of Raceways, Boxes, and Cables" in part 3 of this Section for banding requirements.

T. Communication Conduit and Cables:

1. Cables shall be identified with Brady B-500 vinyl cloth markers or equivalent by L.E.M., Stranco, or Panduit wire markers. Conduit shall be identified with Brady Vinyl Cloth B-500 pipe markers or equivalent. Systems shall be identified as follows:

   a. Each cable shall be identified at each point of entrance to or exit from a conduit or enclosure and at 50-foot intervals in the tray. All identification at 50-foot intervals shall be at the same location in the tray. Each cable shall be identified at control panels, junction boxes, and terminal boards.

   b. Conduit shall be identified exiting an enclosure or panel at junction or pull boxes, and at each side of penetrations of walls, partitions, or floors, within 1-foot of penetration, to identify service type, i.e. "TELEPHONE", "DATA", "CATV", etc...

U. Fire Alarm: Junction box covers shall be painted red. Work switches provided for fire alarm components shall have a red cover plate and labeled "Fire Alarm Circuit". Wiring color code shall match existing Campus protocol.

V. Provide NEC, ANSI, and OSHA-approved *DANGER - HIGH VOLTAGE* warning signs on all doors of dedicated electrical rooms or closets. Where doors are located in finished areas,

locate sign on the inside of the door. Coordinate mounting requirements with the Engineer. Minimum sign dimension shall be 15-inch x 11-inch.

W. Surfaces shall be cleaned and painted, if specified, before applying markings.

X. Place markings so that they are visible from the floor.

Y. Protect finished identification to insure that markings are clear and legible when project is turned over to the Owner.

END OF SECTION

DIVISION 26
SECTION 260573
SHORT CIRCUIT ANALYSIS, COORDINATION STUDY, AND ARC FLASH HAZARD ANALYSIS
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SECTION 260573 - SHORT CIRCUIT ANALYSIS, COORDINATION STUDY, AND ARC FLASH HAZARD ANALYSIS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SCOPE

A. An Engineering Analysis and Coordination Study shall be performed on and include al portion of the electrical distribution system. The analysis shall include a short-circuit analysis with protective device evaluation, a protective device coordination study, time-current analysis of each protective device, and equipment evaluation study.

B. The contractor shall furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E – *Standard for Electrical Safety in the Workplace*. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584-2002, the IEEE *Guide for Performing Arc-Flash Calculations.*

C. The project/report shall begin at the existing overcurrent protective device ahead of the existing 225 kVA pad-mounted transformer, continue to the new 208/120V main distribution panelboard (MDP) and continue through the 208/120V distribution system to the new branch panelboards.

1.3 REFERENCES

A. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 141 – Recommended Practice for Electric Power Distribution and Coordination of Industrial and Commercial Power Systems.
2. IEEE 242 – Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. IEEE 399 – Recommended Practice for Industrial and Commercial Power System Analysis.
4. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings.
5. IEEE 1015 – Recommended Practice for Applying Low-Voltage Circuit Breakers Used in Industrial and Commercial Power Systems.
6. IEEE 1584 – Guide for Performing Arc-Flash Hazard Calculations.

B. American National Standards Institute (ANSI):
   1. ANSI C57.12.00 – Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   2. ANSI C37.13 – Standard for Low Voltage AC Power Circuit Breakers Used in Enclosures.
   3. ANSI C37.010 – Standard Application Guide for AC High Voltage Power Circuit Breakers Rated on a Symmetrical Current Basis.
   4. ANSI C37.41 – Standard Design Tests for High Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches and Accessories.

C. The National Fire Protection Association (NFPA)

   1. NFPA 70 – National Electrical Code, latest edition.
   2. NFPA 70E – Standard for Electrical Safety in the Workplace.

1.4 SUBMITTALS

A. The studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delays in equipment shipments, approval from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.

B. The results of the short-circuit, protective device coordination and arc flash hazard analysis studies shall be summarized in a final report. A minimum of five (5) bound copies of the complete final report shall be submitted. Electronic PDF copies of the report shall be provided upon request.

C. The report shall include the following sections:

   1. Executive Summary including Introduction, Scope of Work and Results/Recommendations.
   2. Short-Circuit Methodology Analysis Results and Recommendations.
   3. Short-Circuit Device Evaluation Table
   4. Protective Device Coordination Methodology Analysis Results and Recommendations.
   5. Protective Device Settings Table
   6. Time-Current Coordination Graphs and Recommendations
   7. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
   8. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images.
   9. One-line system diagram that shall be computer generated and will clearly identify individual equipment buses, bus numbers used in the short circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location, device numbers used in the time-current coordination analysis, and other information pertinent to the computer analysis.

D. Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Engineer and Owner, and other information specified.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 QUALITY ASSURANCE

A. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered State of Delaware Professional Electrical Engineer skilled in performing and interpreting the power system studies. Report shall be signed and sealed by the Engineer.

B. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.

C. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.

D. Engineering Analysis and Coordination Study shall be performed by Coordinated Power Engineering, Inc., or an approved and qualified equal.

1. Cable Testing Services, Inc.
   1212 Calvert Road
   North East, MD 21901
   Telephone: 302-369-5420
   Toll-Free: 1-800-824-1600
   Fax: 302-369-5515
   Contact: Charles Emery, PE

2. AB Engineering LLC
   303 Dressage Court
   West Chester, PA 19382
   Telephone: 610-765-1290
   Contact: Alton Baum, PE

3. Potomac Testing, Inc.
   1610 Professional Blvd, Suite A
   Crofton, MD 21114
   Telephone: 301-352-1930

Toll-Free: 1-800-331-2022
Contact: John F. Mayan, PE

4. Coordinated Power Engineering, Inc.
   1340-G Charwood Road
   Hanover, MD 21076
   Telephone: 410-694-9494
   Fax: 410-694-0085
   Contact: Carl E. Rager, PE

PART 2 - PRODUCTS

2.1 STUDIES

A. The contractor shall furnish an Arc Flash Hazard Analysis Study per NFPA 70E – Standard for Electrical Safety in the Workplace, reference Article 130.3 and Annex D. This study shall also include short-circuit and protective device coordination studies.

2.2 DATA

A. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing or required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final approval of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.

B. Source combination may include present and future motors.

C. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.

D. If applicable, include fault contribution of existing motors in the study. The contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.

2.3 SHORT-CIRCUIT ANALYSIS

A. Transformer design impedances shall be used when test impedances are not available.

B. Provide the following:

1. Calculation methods and assumptions
2. Selected base per unit quantities.
3. One-line diagram of the system being evaluated that clearly identifies individual equipment buses, bus numbers used in the short-circuit analysis, cable and bus connections between the equipment, calculated maximum short-circuit current at each bus location and other information pertinent to the computer analysis.

4. The study shall include input circuit data including electric utility system characteristics, source impedance data, conductor lengths, number of conductors per phase, conductor impedance values, insulation types, transformer impedances and X/R ratios, motor contributions, and other circuit information as related to the short-circuit calculations.
5. Tabulations of calculated quantities including short-circuit currents, X/R ratios, equipment short circuit interrupting or withstand current ratings and notes regarding adequacy or inadequacy of the equipment rating.
6. Results, conclusions, and recommendations. A comprehensive discussion selection evaluating the adequacy or inadequacy of the equipment must be provided and include recommendations as appropriate for improvements to the system.

C. For solidly-grounded systems, provide a bolted line-to-ground fault current study for applicable buses as determined by the engineer performing the study.

D. Protective Device Evaluation:

1. Evaluate equipment and protective devices and compare to short circuit ratings.
2. Adequacy of switchgear, motor control centers, and panelboard bus bars to withstand short-circuit stresses.
3. Contractor shall notify Engineer in writing, of any circuit protective devices improperly rated for the calculated available fault current.

2.4 PROTECTIVE DEVICE TIME-CURRENT COORDINATION ANALYSIS

A. Protective device coordination time-current curves (TCC) shall be displayed on log-log scale graphs.

B. Include on each TCC graph, a complete title with descriptive device names.

C. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.

D. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.

E. Plot the following characteristics on the TCC graphs, where applicable.

1. Electric utility’s overcurrent protective device
2. Medium voltage equipment overcurrent relays
3. Medium and low voltage fuses including manufacturer’s minimum emtl, total clearing, tolerance, and damage bands.
4. Low-voltage equipment circuit breaker trip devices, including manufacturer’s tolerance bands
5. Transformer full load current, magnetizing inrush current, and ANSI through fault protection curves.
6. Medium voltage conductor damage curves.
7. Ground fault protective devices, as applicable.
8. Pertinent motor starting characteristics and motor damage points, where applicable.
9. The largest feeder circuit breaker in each applicable panelboard.

F. Provide adequate time margins between device characteristics such that selective operation is provided, while providing proper protection.

G. Provide the following:

1. A one-line diagram shall be provided which clearly identifies individual equipment buses, bus numbers, device identification numbers and the maximum available short-circuit current at each bus when known.
2. A sufficient number of log-log plots shall be provided to indicate the degree of system protection and coordination by displaying the time-current characteristics of series connected overcurrent devices and other pertinent system parameters.
3. Computer printouts shall accompany the log-log plots and will contain descriptions for each of the devices shown, settings of the adjustable devicse, and device identification numbers to aid in locating the devices on the log-log plots and the system one-line diagram.
4. The study shall include a separate, tabular printout containing the recommended settings of all adjustable overcurrent protective devices, the equipment designation where the devices is located, and the device number corresponding to the device on the system one-line diagram
5. A discussion section which evaluates the degree of system protection and service continuity with overcurrent devices, along with recommendations as required for addressing system protection or device coordination deficiencies.
6. Contractor shall notify Engineer in writing of any significant deficiencies in protection and /or coordination. Provide recommendations for improvements.

2.5 ARC FLASH HAZARD ANALYSIS

A. The arc flash hazard analysis shall be performed according to the IEEE 1584 equations that are presented in NFPA 70E-2009, Annex D. The arc flash hazard analysis shall be performed in conjunction with the short-circuit analysis (Section 2.03) and the protective device time-current coordination analysis (Section 2.04).

B. The flash protection boundary and the incident energy shall be calculated at all locations in the electrical distribution system (distribution panelboard, branch panelboards, etc.) where work could be performed on energized parts.

C. Working distances shall be based on IEEE 1584. The calculated arc flash protection boundary shall be determined using those working distances.

D. When appropriate, the short circuit calculations and the clearing times of the phase overcurrent devices will be retrieved from the short-circuit and coordination study model. Ground overcurrent relays should not be taken into consideration when determining the clearing time when performing incident energy calculations.

E. The short-circuit calculations and the corresponding incident energy calculations for multiple system scenarios must be compared and the greatest incident energy must be uniquely reported for each equipment location in a single table. Calculations must be performed to represent the maximum and minimum contributions of fault current magnitude for normal and emergency operating conditions. The minimum calculation will assume that the utility contribution is at a minimum. Conversely, the maximum calculation will assume a maximum contribution from

the utility. Calculations shall take into consideration the parallel operation of synchronous generators with the electric utility, where applicable as well as any stand-by generator applications.

F. The Arc-Flash Hazard Analysis shall be performed utilizing mutually agreed upon facility operational conditions, and the final report shall describe, when applicable, how these conditions differ from worst-case bolted fault conditions.

G. The incident energy calculations must consider the accumulation of energy over time when performing arc flash calculations on buses with multiple sources. Iterative calculations must take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors should be decremented as follows:

1. Fault contribution from induction motors should not be considered beyond 5 cycles.

H. For each piece of ANSI rated equipment with an enclosed main device, two calculations shall be made. A calculation shall be made for the main cubicle, sides or rear; and shall be based on a device located upstream of the equipment to clear the arcing fault. A second calculation shall be made for the front cubicles and shall be based on the equipment's main device to clear the arcing fault. For all other non-ANSI rated equipment, only one calculation shall be required and it shall be based on a device located upstream of the equipment to clear the arcing fault.

I. When performing incident energy calculations on the line side of a main breaker (as required per above), the line side and load side contributions must be included in the fault calculation.

J. Mis-coordination should be check amongst all devices within the branch containing the immediate protective device upstream of the calculation location and the calculation should utilize the fastest device to compute the incident energy for the corresponding location.

K. Arc Flash calculations shall be based on actual overcurrent protective device clearing time. A maximum clearing time of 2 seconds will be used based on IEEE 1584-2002 section B.1.2. Where it is not physically possible to move outside of the flash protection boundary in less than 2 seconds during an arc flash event, a maximum clearing time based on the specific location shall be utilized.

L. Provide the following:

1. Results of the Arc-Flash Hazard Analysis shall be submitted to tabular form, and shall include device or bus name, bolted fault and arcing fault current levels, flash protection boundary distances, working distances, personal protective equipment classes and AFIE (Arc Flash Incident Energy) levels.
2. The Arc Flash Hazard Analysis shall report incident energy values based on recommended device setting for equipment within the scope of the study.
3. The Arc-Flash Hazard Analysis may include recommendations to reduce AFIE levels and enhance worker safety.

PART 3 - EXECUTION

3.1 FIELD ADJUSTMENT

A. Contractor shall adjust relay and protective device settings according to the recommended setting table provided by the coordination study.

B. Contractor shall make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Contractor shall notify Engineer in writing of any required major equipment modifications.

3.2 ARC FLASH LABELS

A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electrical Code) – Article 110.16

C. The labels shall include the following information:

1. System Voltage
2. Flash Protection boundary
3. Personal Protective Equipment category
4. Arc Flash Incident energy value (cal/cm^2)
5. Limited, restricted, and prohibited Approach Boundaries
6. Study report number and issue date

D. Labels shall be printed by a thermal transfer type printer, with no field markings.

E. Arc flash labels shall be provided for equipment as identified in the study and the respective equipment access areas per the following:

1. Floor Standing Equipment – Labels shall be provided on the front of each individual section. Equipment requiring rear and/or side access shall have labels provided on each individual section access area. Equipment line-ups containing sections with multiple incident energy and flash protection boundaries shall be labeled as identified in the Arc Flash Analysis table.
2. Wall Mounted Equipment – Labels shall be provided on the front cover of a nearby adjacent surface, depending upon equipment configuration.
3. General Use Safety labels shall be installed on equipment in coordination with the Arc Flash labels. The General Use Safety labels shall warn of general electrical hazards associated with shock, arc flash, and explosions, and instruct workers to turn off power prior to work.

F. Labels shall be field installed by Contractor.

3.3 ARC FLASH TRAINING

A. The vendor supplying the Arc Flash Hazard Analysis shall train the Owner's qualified electrical personnel of the potential arc flash hazards associated with working on energized equipment (minimum of 4 hours). The trainer shall be an authorized OSHA Outreach instructor.

B. The vendor supplying the Arc Flash Hazard Analysis shall offer instructor led and online NFPA 70E training classes.

3.4 AVAILABLE FAULT CURRENT LABELING

A. Contractor shall provide a 4.0 in. x 4.0 in. Brady thermal transfer type label of high adhesion polyester for each work location analyzed.

B. The labels shall be designed according to the following standards:

1. UL969 – Standard for Marking and Labeling Systems
2. ANSI Z535.4 – Product Safety Signs and Labels
3. NFPA 70 (National Electrical Code) – Article 110.24.

C. The labels shall include the following information:

1. Line 1 – "Maximum Available Fault Current"
2. Line 2 – "_____ Amperes"; Contractor shall field mark maximum available fault current available at the line terminals of the equipment.
3. Line 3 – Date of Installation

D. Labels shall be printed by a thermal transfer type printer.

E. Labels shall be field-installed by the Contractor.

END OF SECTION

DIVISION 26
SECTION 260923
LIGHTING CONTROL DEVICES
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SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to Division 23 Section "Instrumentation & Controls of HVAC & Plumbing Systems" for interface with exterior lighting.

C. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes time clocks, photoelectric relays, and multipole lighting relays and contactors**.**

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.
2. Division 26 Section "Occupancy Sensors" for wall-mounted and ceiling-mounted occupancy sensors.
3. Division 26 Section, "Programmable Lighting Control System".

1.3 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices. Provide product data on each control device specified.

B. Schedule: Prepare, and submit a contactor and relay schedule. Include the following information in the schedule:

1. Contactor identification
2. Operator Type (Mechanical or Electrical)
3. Contact Configuration and Rating
4. Circuit Numbers Controlled
5. Enclosure Rating
6. Control Circuit
7. Voltage
8. Location

C. Samples: Occupancy sensors for color selection and evaluation of technical features.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Shop Drawings: Indicate control device enclosure wiring diagrams and panel layout drawings.

F. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 01. Include instructions on adjusting, repairing, cleaning and lubricating each control device specified.

G. Project Record Documents: Accurately record actual locations of each product and device, and indicate circuits controlled.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control devices from a single source with total responsibility for compatibility of lighting control system components specified in this Section.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA-70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.

C. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

D. Comply with NFPA 70.

E. Comply with NEMA ICS 2, *Industrial Control Devices, Controllers and Assemblies*.

F. Comply with UL 773A, *Non-Industrial Photoelectric Switches for Lighting Control*.

G. Comply with ANSI/NEMA ICS 6, *Enclosures for Industrial Controls and Systems*.

1.5 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:

1. Division 26 Section “Panelboards”.
2. Division 26 Section “Interior Lighting”.
3. Division 26 Section “Exterior Lighting”.
4. Division 23 Section “Automatic Temperature Control”.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Time Clocks:

a. Diversified Electronics, Inc.
b. Grasslin Controls Corp.
c. Intermatic, Inc.
d. Leviton Manufacturing.
e. Paragon Electric Co., Inc.
f. Tork, Inc.
g. Zenith Controls, Inc.

2. Photoelectric Relays:

a. Allen-Bradley/Rockwell Automation.
b. Area Lighting Research, Inc.
c. Fisher Pierce.
d. Grasslin Controls, Corp.
e. Intermatic, Inc.
f. Paragon Electric Co., Inc.
g. Rhodes: M H Rhodes, Inc.
h. SSAC, Inc.
i. Tork, Inc.

3. Contactors and Relays:

a. Automatic Switch Co.
b. Challenger Electrical Equipment Corp.
c. Cutler-Hammer Products; Eaton Corporation.
d. Furnas Electric Co.

e. GE Lighting Controls.
f. Hubbell Lighting, Inc.
g. Siemens Energy and Automation, Inc.
h. Square D Co.; Power Management Organization.
i. Zenith Controls, Inc.

4. Digital Timer

a. Intermatic, Inc. (Basis of Design)
b. Tork, Inc.
c. Leviton Manufacturing

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations.

2.3 TIME CLOCKS

A. Description: Solid-state programmable units with alphanumeric display complying with UL 917.

B. Description: Electromechanical-dial type complying with UL 917.

1. Astronomic dial.
2. Two contacts (Class A150, SPST), rated 30 A at 277-V ac, unless otherwise indicated.
3. Two pilot-duty contacts, rated 2 A at 240-V ac, unless otherwise indicated.
4. Eight-day program uniquely programmable for each weekday and holidays.
5. Skip-day mode.
6. Permanent schedule retention during power outage and leap year compensation.

C. Cabinet: Install system components in NEMA 1 type hinged lockable enclosure. Provide NEMA Type 4 for outdoor applications.

2.4 TIME CLOCKS-ELECTROMECHANICAL

A. Description: Electromechanical dial-type complying with UL 917 with the following features:

1. Twenty-four (24) hour dial and day-omitting device.
2. Shall be self-powered by a self-starting synchronous motor.
3. Contacts shall be capable of switching 40 amperes per pole continuously at 277 volts, and shall be SPST, SPDT, DPST, or DPDT as required.
4. Removable ON-OFF trippers shall make possible automatic operation with a minimum “ON” period of twenty (20) minutes and a minimum two (2) hours between one “OFF” period and the next.

5. Enclosure shall be NEMA 1, surface-mounted, with combination ½" and ¾" knockouts on bottom, both sides, and back.
6. Provisions for positive padlocking.
7. Terminals shall be capable of receiving #8 AWG wire.
8. Reserve Power Unit: Spring-driven reserve shall be provided sufficient to operate contacts at least sixteen (16) hours after power failure. On restoration of power, time clock shall transfer to synchronous motor drive and automatically rewind reserve power unit.

B. Time Clock shall be TORK Model 7200L, or approved equal by listed manufacturer.

2.5 PHOTOELECTRIC RELAYS

A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A. Contacts shall be fail-safe control so that load will remain "ON" in case of cell failure. Contact shall be rated for Class A150.

B. Light-Level Monitoring Range: 0 to 3500 fc (0 to 37,673 lx), with an adjustment for turn-on/turn-off levels.

C. Time Delay: Prevents false operation.

D. Indoor Ceiling- or Wall-Mounting Units: Adjustable for turn-on/turn-off levels, semiflush, calibrated to detect adequacy of daylighting in perimeter locations, and arranged to turn artificial illumination on and off to suit varying intensities of available daylighting.

E. Indoor Skylight Units: Housed in a threaded plastic fitting for mounting under skylight.

F. Outdoor Sealed Units: Weathertight housing, resistant to extreme temperatures (-30 degrees F to +158 degrees F) and equipped with sun-glare shield and ice preventer.

2.6 OUTDOOR PHOTOCELLS

A. Description: Specification Grade photocell with the following features:

1. Constructed of die-cast zinc, gasketed for weather protection.
2. Cell shall be cadmium sulphide, epoxy coated, one inch diameter.
3. Unit shall have a slide for earlier or later turn on.
4. Delay of up to two (2) minutes to prevent false switching due to light from vehicles or lightning, etc…
5. Contacts shall be normally closed and fail in the "ON" position.
6. Temperature Range: -40 degrees to +140 degrees Fahrenheit.
7. Provided with three (3) color-coded, minimum six (6) inch long wire leads, #16 AWG, rated for 105 degrees Celsius.
8. Photocell shall have a fixed base for mounted through 7/8 inch opening or ½ inch knockout.

B. Photocell shall be TORK Model 2101, or approved equal by listed manufacturer.

2.7 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.

1. Current Rating for Switching: UL listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballasts with 15 percent or less total harmonic distortion of normal load current).
2. Control Coil Voltage: Match control power source.
3. Provide fused control power transformer for each contactor as required by power source.

2.8 MANUAL CONTROL STATIONS

A. Maintain contact (keyed) two-wire device.

B. Two-Position Illuminated Selector Switch: Heavy duty, 10 amp, continuous, 277 volt.

C. Pushbutton On/Off Switch with Indicating Lights: NEMA ICS 2, heavy duty type.

2.9 DIGITAL TIMER

A. Adjustable digital auto shut-off timer.

B. Duration: Deviation 1 second to 24 hours.

C. Load Capacity:

1. Resistance (Heater) 20 amp at 120-277 VAC
2. Tungsten (incandescent) 15 amp at 120 VAC
3. Ballast (fluorescent) 16 amp at 120-277 VAC
4. Motors:

    a. 1 HP at 120 VAC
    b. 2 HP at 240 VAC

5. DC Loads:

    a. 4 amp at 12 VDC
    b. 2 amp at 24 VDC

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division 26 Section “Common Work Results for Electrical”.

C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

D. All products and devices shall be installed in accessible locations.

E. Locate electrically held contactors where the eventual vibration and noise they will produce will not be objectionable to building occupants.

F. Provide enclosures for each individual component.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section “Conductors and Cables” for low-voltage connections and Division 26 Section “Voice and Data Systems” for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section “Raceways and Boxes”, unless run in accessible ceiling space and gypsum board partitions.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: 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.

F. Connect control devices to systems controlled, to achieve proper system operation.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section “Electrical Identification”.

3.4 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing, laboratory labeling, and nameplate compliance with the Contract Documents.

C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

D. Verify settings of photoelectric devices with photometer calibrated within previous six months.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of three hours' training.
2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
3. Schedule training with Owner, through Architect [Engineer], with at least seven days' advance notice.

3.7 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

B. Adjust time delay relays and clock timers to achieve specified system operation.

END OF SECTION

DIVISION 26
SECTION 260925
PROGRAMMABLE LIGHTING CONTROL PANEL
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SECTION 260925 – PROGRAMMABLE LIGHTING CONTROL PANEL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Related Sections include the following:

1. Division 26, Section “Common Work Results for Electrical”.
2. Division 26, Section “Raceway and Boxes”.
3. Division 26, Section “Conductors and Cables”.
4. Division 26, Section “Hangers and Supports”.
5. Division 26, Section “Lighting Control Devices”.
6. Division 26, Section “Occupancy Sensors”.
7. Division 26, Section “Electrical Identification”.
8. Division 26, Section “Interior Lighting”.
9. Division 26, Section “Exterior Lighting”.

C. This project is to be LEED certified. Refer to Division 01 Sections, including “Construction Waste Management”, “General Commissioning Requirements”, “Electrical System Commissioning Requirements”, and “Sustainable Design Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section includes microprocessor-based central dimming controls with the following components:

1. Digital control network
2. Lighting control cabinet and components
3. Low Voltage Wall Keypads
4. Occupancy Sensor
5. Partition Sensor
6. Sensor Integration Module
7. Software
8. Wall stations

B. The extent of programmable lighting control system work is indicated on the drawings and schedules and by the requirements of this Section. The programmable lighting control system is defined to include the control panel, low voltage control devices, low voltage cabling, wiring and software.

C. Work to include all labor materials, tools, appliances, control hardware, sensors, cabling and wire, back boxes, junction boxes, raceway, equipment and software necessary for and incidental to the delivery, installation, and furnishing of a completely operational programmable lighting control system, as described herein.

D. Examine all general specification provisions and drawings for related electrical work required as work under Division 26.

E. Coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit and fixtures.

1.3 DEFINITIONS

A. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.

B. Fade Rate: The time it takes each zone to arrive at the next scene, dependent on the degree of change in lighting level.

C. Fade Time: The time it takes all zones to fade from one lighting scene to another, with all zones arriving at the next scene at the same time.

D. Low Voltage: As defined in NFPA 70, term for circuits and equipment operating at less than 50 V or for remote-control, signaling, and power-limited circuits.

E. Scene: The lighting effect created by adjusting several zones of lighting to the desired intensity.

F. SCR: Silicon-controlled rectifier.

G. Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. For central dimming controls; include elevation, features, characteristics, and labels.
2. For dimmer panels; include dimensions, features, dimmer characteristics, ratings, and directories.
3. Device plates, plate color, and material.
4. Ballasts and lamp combinations compatible with dimmer controls.
5. Sound data including results of operational tests of central dimming controls.
6. Operational documentation for software and firmware.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Include elevation views of front panels of control and indicating devices and control stations.
2. Include diagrams for power, signal, and control wiring.

C. Samples for Initial Selection: For master-control stations, partitioned-space master-control stations, wall stations, dimmer cabinets, and faceplates with factory-applied color finishes and technical features.

D. Samples for Verification: For master-control stations, partitioned-space master-control stations, wall stations, dimmer cabinets, and faceplates with factory-applied color finishes and technical features.

E. The programmable lighting controller shall be manufactured and tested according to the latest standards of the following agencies:

1. UL Approvals

F. Comply with applicable sections of the National Fire Protection Associations (NFPA) 70, National Electric Code (NEC).

1. The control system shall comply with all applicable National Electrical Codes regarding the types of electrical wiring standards.

G. NEMA Compliance.

1. The control system shall comply with all applicable portions of the NEMA standards regarding the electrical equipment enclosures.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For central dimming controls with remote-mounting dimmers to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01Section, "Operation and Maintenance Data," include the following:

a. Software manuals.
b. Adjustments of scene preset controls, adjustable fade rates, and fade overrides.

c. Operation of adjustable zone controls.
d. Testing and adjusting of panic and emergency power features.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of central dimming controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Damage from 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 MANUFACTURERS

A. Basis-of-Design Product: Subject to the compliance requirements, provide products of Crestron Electronics, Inc., Greenlight Integrated Lighting System, Model GLPAC-DIMFLV8 or comparable products from a single manufacturer by one of the following:

1. SensorSwitch – nLight
2. Lutron Electronics Co., Inc.

2.2 GENERAL SYSTEM REQUIREMENTS

A. Lighting Controller: Integrated lighting, dimming, daylight harvesting and equipment switching control system.

B. Provide pre-configured lighting controller, with capabilities for manual setup, and software through programming port.

C. Dimmable Load Types: 16A per channel at 100 to 277VAC, 50/60 Hz:

1. 0-10V 4-wire fluorescent ballasts.
2. 0-10V LED drivers.

D. Switched Load Types:

1. Fluorescent ballast.
2. Incandescent.
3. Magnet low voltage.
4. Motors.

E. Power Requirements:

1. Main Power: 100-277VAC, 50/60 Hz
2. Available Network Power: 10W at 24VDC

F. Compatibility:

1. Dimming components shall be compatible with lighting fixtures, ballasts, and transformers.
2. Individual components shall be compatible with the system network components and shall recognized by the central processor. Individual components shall not impede signal propagation by blocking, limiting or nulling the transmitted signal. Individual components shall be compatible with, but not limited to:

    a. Control Processor.
    b. Low voltage switches.
    c. Scene control switches.
    d. Photocells, both daylight harvesting and dusk-to-dawn.
    e. 0-10V 4-wire fluorescent ballasts.
    f. Occupancy Sensors

2.3 SYSTEM DESCRIPTION

A. Description: Network connected dual bus programmable control processor for low voltage controls, devices, and subsystems for multiple control interfaces.

B. System control shall include, but not limited to switches, occupancy sensors, and photocells.

C. System shall be capable of dimming multiple zones in dedicated spaces as shown on the drawings.

D. Memory: system shall be capable of maintaining program settings without re-programming after loss of power for 10 years.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.

G. Comply with NFPA 70.

2.4 CONTROL NETWORK

A. Dimmers shall receive signals from control stations that are linked to dimmer cabinet with a common network data cable. Cable must meet or exceed manufacturers specifications.

B. Functions of network control stations shall be set up at master station that include the number and arrangement of scene presets, zones, and fade times at wall stations.

1. Control Voltage: 24- or 10-V dc.
2. Comply with ESTA E1.11/USITT DMX 512-A for data transmission.

2.5 PROGRAMMABLE CONTROLLER

A. Functions and Features:

1. Control adjustment of the lighting level for each scene of each zone, and adjustment of fade-time setting for each scene change from one preset to another. Controls shall use low voltage, multichannel keypads.
2. Fade rate for each scene shall be adjustable from zero to 60 seconds.
3. Fade override control for each scene.
4. Recall each preset scene and allow adjustment of zone controls associated with that scene.
5. On, off and scene controls for 0-10 V dimming channel.
6. On and off control of dimming and non-dimming zones.
7. Enable and disable wall stations.
8. Communications link to other processor units.
9. Provide for connecting a portable computer to program the processor.
10. Rear-illuminate all scene-select buttons.

B. Mounting: Single, flush wall box with manufacturer's standard faceplate.

1. Basis of Design: Crestron Electronics, Cameo keypad.

2.6 INFRARED PARTITION SENSOR

A. Description: Infrared surface mounted partition sensor with plug-in outputs and built-in time delay. The output shall consist of a dry contact closure.

1. Basis-of-Design: Crestron Electronics, GLS-PART

B. Functions and Features:

1. Automatically combine and separate lighting and accessory function controls as spaces are configured with movable partitions; with controls for adjustment of the lighting level for on, off and preset scenes at each low voltage keypad.
2. Lighting controller shall accommodate partitioning the space into two (2) adjacent rooms.
3. Low voltage switch channel for on, off and scene control of all zones in tandem when partition is in the open position.

C. Mounting: Surface mounted per manufacturer’s specifications.

2.7 SOFTWARE

A. Description: Web brower based control utilizing Microsoft® ActiveX® foundation to provide fully transformable platform control through GUI design software. Shall be compatible with any Ethernet-equipped 2 or 3 series control system, which supports DHCP/DNS for the integration of IT.

1. Basis-of-Design: Crestron Electronics, e-Control2, VT-Pro-e®.

B. Function and features:

1. Control System Remote LAN Interface System shall provide for a remote control system interface/GUI from a variety of platforms (i.e. Computer, Pocket-PC, Web-Tablet) over a LAN/WAN/Internet.
2. Control System LAN Interface shall require no additional 3rd-party hardware or software for development or use.
3. Control System Remote LAN Interface GUI can be launched as a standalone.exe file from a LAN/PC (increasing speed w/virtually 0-seconds load-time, and increasing security, as only those persons who have the specific .exe file on their PC have access to the control system over the LAN/WAN), a Pocket-PC (PDA) or Web-Tablet, or via a Web-Browser (IE). With Control System Remote LAN Interface using a Web-Browser, the client shall have the option of serving up the Control System Remote LAN Interface Web-Pages from any PC/Server located on the LAN/WAN, or from the control system's built-in web-server.

C. Software shall be configured and customized by lighting control manufacturer.

2.8 LIGHTING CONTROL CABINET

A. Ambient Conditions:

1. Temperature: 30 to 104 deg F (0 to 40 deg C).
2. Relative Humidity: 10 to 90 percent, noncondensing.
3. Filtered air supply.

B. Dimmer Cabinet Assembly: NRTL listed and labeled.

C. Cabinet Type: Plug in, modular, and accepting dimmers of each specified type in any plug-in position.

1. Integrated Fault-Current Rating: 10,000-A RMS symmetrical.

D. Lighting Dimmers: Solid-state SCR dimmers.

1. Primary Protection: Magnetic or thermal-magnetic circuit breaker, also serving as the disconnecting means.
2. Dimmer response to control signal shall follow the "Square Law Dimming Curve" specified in IESNA's "IESNA Lighting Handbook."

3. Dimming Range: 0 to 100 percent, full output voltage not less than 98 percent of line voltage.
4. Dimmed circuits shall be filtered to provide a minimum 350-mic.sec. current-rise time at a 90-degree conduction angle and 50 percent of rated dimmer capacity. Rate of current rise shall not exceed 30 mA/mic.sec., measured from 10 to 90 percent of load-current waveform.

E. Non-dim modules shall include relays with contacts rated to switch 16-A tungsten-filament load at 120-V ac and 16-A electronic ballast load at 277-V ac.

F. Accessory function control modules shall be compatible with requirement of the accessory being controlled.

G. Digital Control Network:

1. Dimmers shall receive digital signals from digital network control stations that are linked to the dimmer cabinet with a common network data cable.
2. Functions of digital network control stations shall be set up at the dimmer cabinet's electronic controls that include indicated number and arrangement of scene presets, channels, and fade times.

2.9 DUAL-TECHNOLOGY OCCUPANCY SENSOR

A. Description: Occupancy sensor connected to the lighting control network and shall be compatible with the network when connected directly or through an interface.

1. Basis-of-Design: Crestron Electronics

a. Ceiling Mounted:
i. Corridors: GLS-ODT-C-2000
ii. Others: GLS-ODT-C-500

b. Wall and corner-mounted:
i. GLS-ODT-W-1200

B. Function and features:

1. Ultrasonic motion detection achieves high sensitivity to small movements over a large area.
2. Passive infrared ensures superior immunity to false triggering from air currents, inanimate objects, or movement in an adjacent corridor.

C. Mounting: Ceiling or Wall Mounted.

D. Refer to Division 26 Section, “Occupancy Sensors”, Paragraphs “SUBMITTALS” and “INSTALLATIONS” for additional requirements.

2.10 CLOSED-LOOP PHOTOCELL

A. Description: Photocell sensor designed for daylight harvesting applications to control the balance of natural and artificial lighting in an indoor space.

B. Function and features:

1. 24 Volt DC
2. Provide 0-10 Volts DC analog control signal proportionate to the ambient light level.
3. Provides continuous feedback for precise control of room lighting.

C. Mounting: Ceiling or Wall Mounted.

2.11 SENSOR INTEGRATION MODULE

A. Description: Where required per manufacturer's instruction, install compact interface device designed to allow sensors to connect directly to the control network. The integration module is a flexible 4-wire bus providing data communications and 24 Volts DC power for all of the devices on the network.

1. Basis of Design: Crestron Electrics, GLS-SIM.

2.12 CONDUCTORS AND CABLES

A. Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements of Division 26 Section, "Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements of Division 26 Section, "Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14, No. 16, or No. 18 AWG. Comply with requirements of Division 26 Section, "Conductors and Cables."

D. All wiring and cabling to meet or exceed manufacturer's requirements.

PART 3 - EXECUTION

3.1 WIRING INSTALLATION

A. Comply with NECA 1.

B. Wiring Method:

1. Comply with requirements in Section 260519.
2. Install unshielded, twisted-pair cable for control and signal transmission conductors.

3. Minimum conduit size shall be 3/4 inch.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.

E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

F. Install dimmer cabinets for each zone.

3.2 IDENTIFICATION

A. Comply with requirements in Division 26 Section, "Electrical Identification" for identifying components and power and control wiring.

B. Label each dimmer module with a unique designation.

C. Label each scene control button with approved scene description.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Continuity tests of circuits.
2. 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.

D. Remove and replace malfunctioning dimming control components and retest as specified above.

E. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.4 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with 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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain central dimming controls. Laptop portable computer shall be used in training.

B. Coordinate demonstration of products specified in this Section with commissioning requirements for low-voltage, programmable lighting control system specified in Division 01 Section, “Electrical Systems Commissioning Requirements”.

END OF SECTION

DIVISION 26
SECTION 260926
OCCUPANCY SENSORS
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SECTION 260926 - OCCUPANCY SENSORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 Section, "Low Voltage Lighting Control System".

C. Division 26 Section, "Programmable Lighting Control System'".

D. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 WORK INCLUDED

A. Work to include all labor materials, tools, appliances, control hardware, sensor, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational occupancy sensor lighting control system, as described herein.

B. Examine all general specification provisions and drawings for related electrical work required as work under Division 26.

C. Coordinate all work described in this section with all other applicable plans and specifications, including but not limited to wiring, conduit and fixtures.

1.3 EQUIPMENT QUALIFICATION

A. Products supplied shall be from a manufacturer that has been continuously involved in the manufacturing of occupancy sensors for a minimum of five (5) years.

B. All components shall be UL listed, offer a five (5) year warranty and meet all state and local applicable code requirements.

1.4 SYSTEM DESCRIPTION

A. The objective of this section is to ensure the proper installation of the occupancy sensor based lighting control system so that lighting is turned off automatically after reasonable time delay when a room or area is vacated by the last person to occupy said room or area.

B. The occupancy sensor based lighting control shall accommodate all conditions of space utilization and all irregular work hours and habits.

C. Warrant all equipment furnished in accordance to this specification to be undamaged, free of defects in materials and workmanship, and in conformance with the specifications. The suppliers' obligation shall include repair or replacement and testing, without charge to the Owner, all or any parts of equipment which are found to be damaged, defective or non-conforming and returned to the supplier. The warranty shall commence upon the Owner's acceptance of the project. Warranty on labor shall be for a minimum period of two (2) years.

1.5 SUBMITTALS

A. Manufacturer shall substantiate conformance to this specification by supplying the necessary documents, performance data and wiring diagrams. Any deviations to this specification must be clearly stated by letter and submitted.

B. Submit a lighting plan clearly marked by manufacturer showing proper product, location and orientation of each sensor. Submit Shop Drawings indicating wiring diagrams, showing interface with branch circuit wiring.

C. Submit any interconnection diagrams per major subsystem showing proper wiring.

D. Submit standard catalog literature which includes performance specifications indicating compliance to the specification. Provide product data showing dimensions and ratings of components.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.6 SYSTEM OPERATION

A. Responsibility to make all proper adjustments to assure Owner's satisfaction with the occupancy system.

1.7 ACCEPTABLE MANUFACTURERS

A. Watt Stopper, Sensor Switch, Hubbell or approved equal.

B. The listing of any manufacturer as *acceptable* does not imply automatic approval. Ensure that any price quotations received and submittals made are for sensors which meet or exceed the specifications included herein.

PART 2 - PRODUCTS

2.1 GENERAL

A. Product numbers for Watt Stopper are as follows:

1. Ceiling-mounted Sensors:

   a. Corridors: WT-2255 (white)
   b. Other Spaces: DT-300 (white)

2. Wall and corner-mounted Sensors: DT-200 (white) with wire guards as indicated on drawings.
3. Wall Switch Sensors:

   a. Single Relay: DW-100 (ivory).
   b. Dual Relay: DW-200 (ivory).

4. Power Pack Modules: BZ-150 (dual voltage).

B. Wall switch sensors shall be capable of detection of motion at desk-top level up to 300 square feet, and gross motion up to 1,000 square feet.

C. Wall switch sensors shall accommodate loads from 0 to 800 watts at 120 volts; 0 to 1200 watts at 277 volts and shall have 180-degree coverage capability.

D. Sensors shall be dual-technology type using a combination of passive-infrared and ultrasonic detection method to distinguish between occupied and unoccupied conditions for area covered.

E. Sensors shall feature built-in light level sensing for field-adjustable ambient light override.

F. All sensors shall be capable of operating normally with any electronic ballast and PL lamp systems.

G. Coverage of sensors shall remain constant after sensitivity control has been set. No automatic reduction shall occur in coverage due to the cycling of air conditioner or heating fans.

H. All sensors shall have readily accessible, user adjustable controls for time delay and sensitivity. Controls shall be recessed to limit tampering.

I. In the event of failure, a bypass manual *override on* shall be provided on each sensor. When bypass is utilized, lighting shall remain on constantly or control shall divert to a wall switch until sensor is replaced. This control shall be recessed to prevent tampering.

J. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005 percent tolerance to assure reliable performance and eliminate sensor cross-talk. Sensors using multiple frequencies are not acceptable.

K. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working.

L. All sensors shall have no leakage current to load, in manual or in Auto/Off Mode, for safety purposes and shall have voltage drop protection.

M. All sensors shall have UL rated, 94V-0 plastic enclosures.

2.2 CIRCUIT CONTROL HARDWARE:

A. Power Pack Modules - for ease of mounting, installation and future service, Power Pack(s) shall be able to externally mount through a ½-inch knock-out on a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of three (3) sensors. Power Packs shall be UL listed.

B. Relay Contacts shall have ratings of:

20A - 120 VAC Tungsten
20A - 120 or 277 VAC Ballast

2.3 CONTROL WIRING BETWEEN SENSORS AND CONTROLS

A. Control wiring between sensors and controls shall be Class II, 18-24 AWG, stranded UL Classified, PVC-insulated or Teflon-jacketed cable approved for use in plenums, where applicable.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have ninety (90) to one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be

provided with sensors. Provide additional sensors if required to properly and completely cover the respective room.

B. The following areas shall have one hundred (100%) percent coverage for small-motion:

1. Teacher's desks
2. Desks in office areas

C. Arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the Owner's facility, to verify placement of sensors and installation criteria.

D. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. Provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem-solving diagnosis of the occupancy-sensing devices and systems.

1. Sensors shall be mounted where they will not receive light directly from a light source or reflecting source.
2. Sensor shall be mounted at least 4 feet from HVAC vents to avoid air current interference.
3. Sensors installed in damp locations such as near showers, in wet locations, or where exposed to rain shall be equipped with watertight/weatherproof enclosure.
4. Mounting of passive infrared and dual technology sensors where columns, doors, walls, or other obstructions will block the sensor's field of view should be avoided.

E. Passive infrared coverage should not extend through doorways. Masking inserts shall be installed for PIR coverage rejection to prevent false tripping.

F. Install system components in accordance with Manufacturer's instructions. Sensor locations are approximate and are designed according to the specified manufacturer.

G. Sensors shall be positioned so that lights are activated when a person is 2 feet or less through any doorway.

H. Prior to energizing circuits, wiring shall be tested for electrical continuity and short circuits to ensure proper polarity of connections is maintained.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section "Conductors and Cables" for low-voltage connections.

B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section "Raceways and Boxes", unless run in accessible ceiling space and gypsum board partitions.

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: 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.

F. Connect control devices to systems controlled, to achieve proper system operation.

3.3 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Electrical Identification".

3.4 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

C. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

D. Verify settings of photoelectric devices with photometer calibrated within previous six months.

E. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

F. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

G. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.

H. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 FACTORY COMMISSIONING:

A. Upon completion of the installation, the system shall be completely tested by the manufacturer's factory-authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system. This service is to be provided at no additional cost.

B. Provide both the manufacturer and the Engineer with ten working days written notice of the scheduled testing date. Upon completion of the system fine tuning, the factory-authorized technician shall provide the proper training to the Owner's personnel in the adjustment and maintenance of the sensors.

END OF SECTION

DIVISION 26
SECTION 261200
MEDIUM VOLTAGE TRANSFORMERS
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SECTION 261200 - MEDIUM 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SCOPE

A. Applicable provisions of Division 01 shall apply to all work under this Section.

1.3 SUBMITTALS

A. Shop Drawings

1. Submit product data under provisions of General Conditions of the Contract and Section "Common Work Results for Electrical".
2. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, kVa, and impedance ratings and characteristics, loss data, efficiency at 25, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.
3. Include detailed drawings of any changes to existing installations to suit proposed equipment to be furnished.
4. Include manufacturer's installation instructions.
5. Submit a ¼-inch scaled shop drawing indicating transformer(s), equipment pad, clearances, dimensions, existing conditions, and other major components. Shop drawing shall be specific to location being installed.

B. Factory Certified Tests

1. Factory certified tests shall be performed on the transformer being supplied and the results presented to the Project Manager for approval before shipment. The following factory certified tests shall be performed:

    a. Insulation resistance tests shall be performed winding-to-winding and winding-to ground.
    b. A turns ratio test shall be performed between windings at all service tap settings.

c. Overpotential test shall be made on all high and low voltage windings to ground.
d. Winding resistance tests shall be made for each winding at the in-service tap.
e. Verify that the tap settings/changer is at the desired ratio.
f. Measure secondary voltage phase-to-phase and phase-to-ground after final energization and prior to loading.
g. Verify and/or connect transformer "XO" to ground, load side of "WYE" systems.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of General Conditions of the Contract and Division 26 Section, “Common Work Results for Electrical”.

B. Include procedures for cleaning unit, maintaining fluid levels, and replacing components.

1.5 QUALITY ASSURANCE

A. Manufacturer: Company specializing in distribution transformers with ten years experience.

B. Comply with the latest requirements of IEEE, ANSI, ASTM, NEMA, and ASA-NEMA Standards.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store and protect equipment in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.

B. Protect dry type transformers from moisture by using appropriate heaters as instructed by the manufacturer.

C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.1 OIL-FILLED TRANSFORMERS

A. Manufacturers:

1. ABB
2. Cooper
3. Square D

B. Furnish and install at the locations indicated on drawings completely metal enclosed, compartmented, oil-filled, pad-mounted distribution transformers.

C. Equipment shall have the following ratings:

1.	Capacity	-	KVA rating as indicated on the Drawings @ 65 degrees C Rise.
2.	Primary Voltage	-	12 kV (11,847 Volts) (Delta).
3.	Secondary Voltage	-	480Y/277V (WYE).
4.	Taps	-	Two (2) @ 2-1/2 percent Above and Below Nominal.
5.	Phase	-	Three.
6.	Frequency	-	60 Hertz.
7.	B.I.L.	-	95 kV.
8.	Insulation	-	O.I.S.C.
9.	Impedance	-	5.75 percent Nominal

D. The unit shall be constructed for outdoor, fenceless, weatherproof service, and shall be suitable for mounting directly on the concrete foundation pad with high and low voltage cable entrance from below. The front of the unit shall contain an air-filled termination chamber divided with a steel barrier into two sections. The left section shall contain three 15 kV porcelain live front eyebolt horizontal bushings situated to provide at least 30-inches of vertical space for cable training and termination. Include three 15 kV distribution class metal oxide surge arrestors mounted in this compartment connected to the above bushings. The low voltage compartment shall contain four 8-hole NEMA drilled spade type side wall porcelain bushings, factory-wired to three 3-pole molded case circuit breakers (as required and shown on the drawings, frame-mounted in compartment for exiting load side cables out the bottom. Interrupting capacity shall be a minimum of 42,000 amperes symmetrical. Provide low voltage barrier.

E. The transformer shall be of sealed tank construction and furnished with the following:

1. Combination drain and sampler valve (minimum 1-inch).
2. Upper filter press connection.
3. Liquid level gauge.
4. Dial thermometer.

5. Manual tap changer handle.
6. Pressure relief valve.
7. Lifting lugs.
8. Grounding pads.
9. Jacking lugs.
10. Tamper-proof handhole on tank.
11. Diagrammatic nameplate.
12. Provisions for padlocking and recessed bolting the hinged doors of the air terminal chamber with access to the high voltage section only after opening the low voltage section door.
13. Non-PCB Certification label.
14. ANSI Tank Ground Pad.
15. Filling plug-mounted in the cover.
16. Tap changer handle.
17. Vacuum/Pressure Gauge.
18. Liquid Temperature Gauge.
19. Winding Temperature Gauge with alarm contacts and control relays.
20. *WARNING - HIGH VOLTAGE* Label.

F. The unit shall be constructed of welded steel plate with no exposed boltheads, protrusions, sharp edges, or openings which would permit entrance by other than authorized personnel. The entire assembly shall be cleaned of weld scale, primed, and given a finish coat of "Forest Green", oil-resistance outdoor enamel paint, or other color as selected by the Owner.

G. The transformer shall be manufactured and tested in accordance with the latest applicable requirements of IEEE, NEMA and ANSI.

H. Liquid: Oil or less flammable liquid may be used depending on where installed and how the vault is constructed. All oil shall be non-PCB. A permanent label shall be affixed to the tank indicating transformer dielectric fluids contained less than 50 PPM of PCB in accordance with EPA Requirements at the time of shipment.

I. Primary Terminations:

1. For radial feed transformers, specify three (3) ANSI/IEEE 386 bushing wells, insulated loadbreak connectors with parking stands, and one (1) internal oil-immersed, two-position load-break switch.

J. Primary Overcurrent Protection: Two fuse system consisting of Bayonet-type, oil-immersed expulsion fuse in series with current-limiting backup fuse mounted inside the transformer under oil. The current limiting fuse should be located as near as practical to the incoming primary bushing, on the source side of the expulsion fuse. The two fuses shall be coordinated so that the expulsion fuse clears low energy faults on the secondary system and the current limiting fuse clears only high energy, includes overload protection, can be provided as an alternate with approval from the Owner. All transformer fusing shall be coordinated with upstream phase overcurrent devices.

K. Copper windings.

L. Transformer Start-Up: The transformer will not be started until all tests are complete and turned over to the Owner and the Engineer (2 sets) for review and approval.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify field measurements are as shown on Drawings.

B. Verify that required utilities are available, in proper location and ready for use.

C. Beginning of installation means installer accepts conditions.

3.2 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Set transformer plumb and level.

C. Connect transformer to adjacent equipment using new cables or existing bus to match existing configuration.

D. Mount primary surge arresters inside of transformers.

E. Provide safety labels per NEMA 260.

3.3 EQUIPMENT MOUNTING PADS:

A. Provide concrete pads as required for setting outdoor pad-mounted transformers and switches and other floor or ground-mounted equipment. Concrete shall be 3000 psi, 28-day minimum and as specified in Division 03 Section “Concrete Work”. Refer to detail on Electrical Contract Drawings for outdoor electrical equipment pads.

3.4 OUTDOOR EQUIPMENT PROTECTION (BOLLARDS)

A. Outdoor, pad-mounted transformers and other gear shall be protected from damage by vehicles by steel bollards. Typical bollard locations are indicated on the Drawings. Placement of bollards around electrical equipment shall be well-planned such that bollards are not placed over ground rods, ground wires, etc. Bollard locations shall also be coordinated with door swings of all enclosures. Allow all required clearances. See Protective Bollard Detail on the Electrical Contract Drawings for construction requirements.

3.5 FIELD QUALITY CONTROL

A. Oil Field Transformers: Field testing will be performed by independent testing agency provided by the Contractor. Perform testing as required by NETA and as follows:

1. Sample insulating liquid in accordance with ASTM D3613 and perform dissolved gas analysis (DGA) in accordance with ANSI / IEEE and ASTM.
2. Turns ratio tests on the rated voltage connection and on all tap connections.
3. Polarity and phase-relation tests on the rated voltage connection.
4. Power factor tests in accordance with manufacturer's instructions.
5. Dielectric absorption test, winding-winding, and winding-ground.
6. Winding resistance for each winding at nominal tap position.

B. Any equipment which fails any of the required tests shall be replaced with new, or repaired at Owner's discretion. Equipment with marginal results, as interpreted by the Owner or Engineer, shall also be replaced or repaired at the Owner's discretion.

C. Check for damage and tight connections prior to energizing transformer.

3.6 ADJUSTING

A. Adjust primary taps so that secondary voltage is within 1.5 percent of rated voltage.

END OF SECTION

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MEDIUM VOLTAGE SWITCHGEAR
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SECTION 261301 - MEDIUM 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, Specifications Sections apply to this Section.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 REFERENCE

A. All work under this Section shall be subject to Division 26 Section "Common Work Results for Electrical" and any applicable conditions hereinbefore written for the entire work.

B. This section describes metal-enclosed switchgear assembly for application as Customer-Owned 12 kV service entrance equipment for installation on campus owned medium voltage loop.

C. Three (3) sets of Manufacturer's shop drawings for the entire service entrance switchgear assembly shall be submitted to local utility company for review and approval, in addition to Shop Drawings required for Owner/Engineer approval.

1.3 CODES AND STANDARDS:

A. The equipment furnished under this Section shall be in accordance with the latest applicable standards of ANSI, NEMA, IEEE, ICEA, OSHA, National Electrical Code, and local utility company.

B. Where any requirements specified herein or shown on the Contract Drawings exceed the listed standards, adhere to the higher standard. In case of conflict in requirements between two of more standards, decision of the Engineer shall be final.

C. All equipment and materials furnished under this Section shall meet the requirements of the local utility and shall conform to all Federal, State, and Local laws or ordinances, and if any requirements shown or specified conflicts with such requirements, laws or ordinances, provide such changes as are necessary to meet said requirements. The cost of such changes shall be included in the original bid. Where any standards shown on the Contract Drawings or specified herein exceed the minimum standards set by law, adhere to the higher standard.

D. Where applicable, all equipment and materials shall be listed and labeled by a nationally-recognized testing laboratory with equipment listing and follow-up service.

E. Switchgear shall be UL listed.

F. References

1. ANSI/IEEE C37.20.3 - (latest edition) - Standard for Metal-Enclosed Interrupter Switchgear.
2. ANSI/IEEE C37.30 - (latest edition) - Standard Definitions and Requirements for High-Voltage Air Switches, Insulators, and Bus Supports.
3. ANSI/IEEE C37.32- (latest edition) - Standard Schedules of Preferred Ratings, Manufacturing Specifications, and Application Guide for High-Voltage Air Switches, Bus Supports, and Switch Accessories.
4. ANSI/IEEE C37.34 - (latest edition) - Test Code for High Voltage Air Switches.
5. ANSI/IEEE C37.35- (latest edition) - Guide for the Application, Installation, Operation, and Maintenance of High-Voltage Air Disconnecting and Load Interrupter Switches.
6. ANSI Z55.1 - Gray Finishes for Industrial Apparatus and Equipment.
7. Local Electrical Codes.
8. NFPA 70- 2011- National Electrical Code.

1.4 SUBMITTALS

A. Provide third party certified test abstracts for all air interrupter switchgear proposed for use on this project prior to shop drawing submittal and not later than twenty-one days after award of contract. The certified test abstracts shall contain, as a minimum, the manufacturer's current engineering sales brochure showing all equipment proposed with model numbers (if available), and a summary of test procedures (described below) and resultant values actually recorded during the tests. The test procedure and resultant values summary shall contain model numbers (if available) similar to those listed in the current engineering sales brochure.

B. The following tests shall be performed on assemblies similar to those proposed for this project. Assemblies shall be completer with enclosure and all internal components such as switch, fuses (if required), ground pads, ground rods, metal and insulating barriers, etc.

1. Short-time current testing, to include rated momentary and rated three second tests as defined in ANSI/IEEE C237.30.4.6- (latest edition) and C37.20.3.5.2- (latest edition).
2. Rated continuous current and temperature rise testing as defined in ANSI/IEEE C37.32.3.2-1972, C37.20.3.5.2- (latest edition) , and C37.30.4.5- (latest edition) .
3. Dielectric testing to include impulse withstand and 60 Hz tests as defined in ANSI/IEEE C37.32.3.2- (latest edition) .
4. Load current interrupting testing as defined in ANSI/IEEE C37.30.4.7- (latest edition).
5. Fault closing tests within the enclosure: 3 phase testing on the switch and 1 phase testing on the fuses as defined in ANSI/IEEE C37.30.4.14- (latest edition) .

6. Finish testing as defined in ANSI/IEEE C37.20.3.5.2.8- (latest edition) . Samples must be prepared by the equipment manufacturer, not by the coating vendor, using production painting equipment with production paint applied on production substrates identical to that used of this project's equipment.

C. Submit the following shop drawings under the provisions of General Conditions of the Contract and of Division 26, Section “Common Work Results for Electrical”.

1. Outline dimensions, enclosure construction, shipping splits, lifting and supporting points.
2. Conduit and cable entrance locations.
3. Electrical single line diagram.
4. Key interlock flow diagram.
5. Equipment electrical ratings.
6. Certification of ratings of the integrated metal-enclosed switchgear assembly consist of the basic switch and fuse components in combination with the enclosure.
7. Product data for components and accessories.
8. Manufacturer's installation instructions.
9. Fuse curves for proposed fuses.

D. Submit coordination and relay settings calculations.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of General Conditions.

B. Include parts list, fuse replacement, equipment adjustment, and lubrication instructions.

1.6 QUALITY ASSURANCE

A. Enclosure Manufacturer: Company specializing in medium voltage interrupter switch enclosures with five years documented experience.

B. Switch Manufacturer: Company specializing in medium voltage interrupter switch components with five years documented experience.

C. Fuse Manufacturer; Company specializing in medium voltage fuses and fuse components with five years documented experience.

D. The manufacturer/assembler of the overall switchgear assembly shall be completely and solely responsible for the performance of the basic switch as well as the complete integrated assembly as rated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 16010 and General Conditions.

B. Store and protect products.

C. Accept switchgear on site and inspect of damage.

D. Protect switchgear from weather and moisture by covering with heavy plastic or canvas and by maintaining heat within enclosure in accordance with manufacturer's instructions.

1.8 EXTRA MATERIALS

A. Provide maintenance materials under provisions of Section Division 26, Section “Common Work Results for Electrical” and General Conditions.

B. Provide one set of spare fuses for each set installed. Place these spare fuses in the metal pocket in the front door of each fused switch assembly.

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, the following:

1. S & C Electric (Basis of Design)

2.2 ENCLOSURE DESIGN

A. To ensure a completely coordinated design, the pad-mounted gear shall be constructed in accordance with the minimum construction specifications of the fuse and/or switch manufacturer to provide adequate electrical clearances and adequate space for fuse handling.

B. In establishing the requirements for the enclosure design, consideration shall be given to all relevant factors such as controlled access, tamper resistance, and corrosion resistance.

2.3 RATINGS

A. Ratings: The ratings for the integrated pad-mounted gear shall be as designated below.

1. kV, Nominal: 14.4
2. kV, Maximum: 17
3. kV, BIL: 95
4. Main Bus Continuous, Amperes: 600

B. Three-Pole Interrupter Switches

1. Continuous, Amperes: 600
2. Load Dropping, Amperes: 400
3. Two-Time Duty-Cycle Fault-Closing, Amperes RMS Asymmetrical: 22,400

C. Fuses with Integral Load Interrupter

1. Maximum, Amperes: 200
2. Load Dropping, Amperes: 200
3. Two-Time Duty-Cycle Fault-Closing Capability, Amperes RMS Asymmetrical: 13,000

D. Short-Circuit Ratings

1. Amperes RMS Symmetrical: 14,000
2. MVA Three-Phase Symmetrical at Rated Nominal Voltage: 350

E. The momentary and two-time duty-cycle fault-closing ratings of switches, momentary rating of bus, interrupting ratings of fuses, and one-time duty-cycle fault-closing capabilities of fuses with integral load interrupters shall equal or exceed the short-circuit ratings of the pad-mounted gear.

F. The manufacturer of the pad-mounted gear shall be completely and solely responsible for the performance of the basic switch and fuse components as well as the complete integrated assembly as rated.

G. The manufacturer shall furnish, upon request, certification of ratings of the basic switch and fuse components and/or the integrated pad-mounted gear assembly consisting of the switch and fuse components in combination with the enclosure.

2.4 INSULATION

A. The interrupter-switch and fuse-mounting insulators shall be of a cycloaliphatic epoxy resin system with characteristics and restrictions as follows:

B. Operating experience of at least 15 years under similar conditions.

C. Adequate leakage distance established by test per IEC Publication 507, First Edition, 1975.

D. Adequate strength for short-circuit stress established by test.

E. Conformance with applicable ANSI standards.

F. Homogeneity of the cycloaliphatic epoxy resin throughout each insulator to provide maximum resistance to power arcs. Ablation due to high temperatures from power arcs shall continuously expose more material of the same composition and properties so that no change in mechanical or electrical characteristics takes place because of arc-induced ablation. Furthermore, any surface damage to insulators during installation or maintenance of the pad-mounted gear shall expose material of the same composition and properties so that insulators with minor surface damage need not be replaced.

2.5 HIGH VOLTAGE BUS

A. Bus and interconnections shall consist of aluminum bar of 56% IACS conductivity.

B. Bus and interconnections shall withstand the stresses associated with short-circuit currents up through the maximum rating of the pad-mounted gear.

C. Bolted aluminum-to-aluminum connections shall be made with a suitable number of 1/2" galvanized steel bolts and with two Belleville spring washers per bolt, one under the bolt head and one under the nut. Bolts shall be tightened to manufacturers specifications.

D. Before installation of the bus, all electrical contact surfaces shall first be prepared by machine abrading to remove any aluminum-oxide film. Immediately after this operation, the electrical contact surfaces shall be coated with a uniform coating of an oxide inhibitor and sealant.

2.6 GROUND-CONNECTION PADS

A. A ground-connection pad shall be provided in each compartment of the pad-mounted gear.

B. The ground-connection pad shall be constructed of 3/16” thick steel, which shall be nickel plated and welded to the enclosure, and shall have a short-circuit rating equal to that of the pad-mounted gear.

C. Ground-connection pads shall be coated with a uniform coating of an oxide inhibitor and sealant prior to shipment.

2.7 ENCLOSURE

A. The pad-mounted gear enclosure shall be of unitized monocoque (not structural-frame-and-bolted-sheet) construction to maximize strength, minimize weight, and inhibit corrosion.

B. The basic material shall be 11-gauge hot-rolled, pickled and oiled steel sheet.

C. All structural joints and butt joints shall be welded, and the external seams shall be ground flush and smooth. The gas-metal-arc welding process shall be employed to eliminate alkaline residues and to minimize distortion and spatter.

D. To guard against unauthorized or inadvertent entry, enclosure construction shall not utilize any externally accessible hardware.

E. The base shall consist of continuous 90-degree flanges, turned inward and welded at the corners, for bolting to the concrete pad.

F. The door openings shall have 90-degree flanges, facing outward, that shall provide strength and rigidity as well as deep overlapping between doors and door openings to guard against water entry.

G. Polyurethane self-adhesive bumpers shall be placed on the left-hand door channel to prevent the right-hand door from abrading the paint, and on the center door divider to prevent the left-hand door from rubbing against the center door divider.

H. Enclosure top side edges shall overlap with roof side edges to create a mechanical maze which shall allow ventilation to help keep the enclosure interior dry while discouraging tampering or insertion of foreign objects.

I. A heavy coat of insulating "no-drip" compound shall be applied to the inside surface of the roof to minimize condensation of moisture thereon.

J. Insulating interphase and end barriers of NEMA GPO3-grade fiberglass-reinforced polyester shall be provided for each interrupter switch and each set of fuses where required to achieve BIL ratings. Additional insulating barriers of the same material shall separate the front compartments from the rear compartments and isolate the tie bus (where furnished).

K. Full-length steel barriers shall separate side-by-side compartments.

L. Interrupter switches shall be provided with dual-purpose front barriers. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift the barriers out and insert them into the open gap when the switch is open. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

M. Interrupter switches shall be provided with window panels to allow viewing of the switch position without removing the dual-purpose front barriers. Window panels shall be removable to facilitate phasing and shall be secured to the enclosure with stainless-steel or zinc-nickel-plated hardware.

N. Each fuse shall be provided with a dual-purpose front barrier. These barriers, in their normal hanging positions, shall guard against inadvertent contact with live parts. It shall also be possible to lift these barriers out and insert them into the open gaps when the fuses are in the

disconnect position. These barriers shall meet the requirements of Section 381G of the National Electrical Safety Code (ANSI Standard C2).

O. The enclosure shall be provided with an instruction manual holder.

P. Lifting tabs shall be removable. Sockets for the lifting-tab bolts shall be blind-tapped. A resilient material shall be placed between the lifting tabs and the enclosure to help prevent corrosion by protecting the finish against scratching by the tabs. To further preclude corrosion, this material shall be closed-cell to prevent moisture from being absorbed and held between the tabs and the enclosure in the event that lifting tabs are not removed.

Q. A non-compartmented base spacer shall be provided to increase the elevation of live parts in the pad-mounted gear above the mounting pad by 12 inches.

2.8 DOORS

A. Doors shall be constructed of 11-gauge hot-rolled, pickled and oiled steel sheet.

B. Door-edge flanges shall overlap with door-opening flanges and shall be formed to create a mechanical maze that shall guard against water entry and discourage tampering or insertion of foreign objects, but shall allow ventilation to help keep the enclosure interior dry.

C. Doors shall have a minimum of two extruded-aluminum hinges with stainless-steel hinge pins, and interlocking extruded-aluminum hinge supports for the full length of the door to provide strength, security, and corrosion resistance. Mounting hardware shall be stainless steel or zinc-nickel-plated steel, and shall not be externally accessible to guard against tampering.

D. In consideration of controlled access and tamper resistance, each door (or set of double doors) shall be equipped with an automatic three-point latching mechanism.

1. The latching mechanism shall be spring loaded, and shall latch automatically when the door is closed. All latch points shall latch at the same time to preclude partial latching.
2. A pentahead socket wrench or tool shall be required to actuate the mechanism to unlatch the door and, in the same motion, recharge the spring for the next closing operation.
3. The latching mechanism shall have provisions for padlocking that incorporate a means to protect the padlock shackle from tampering and that shall be coordinated with the latches such that:

    a. It shall not be possible to unlatch the mechanism until the padlock is removed, and
    b. It shall not be possible to insert the padlock until the mechanism is completely latched closed.

4. Doors providing access to solid-material power fuses shall have provisions to store spare fuse units or refill units.

5. Each door shall be provided with a zinc-nickel-plated steel door holder located above the door opening. The holder shall be hidden from view when the door is closed, and it shall not be possible for the holder to swing inside the enclosure.

2.9 FINISH

A. Full coverage at joints and blind areas shall be achieved by processing enclosures independently of components such as doors and roofs before assembly into the unitized structures.

B. All exterior seams shall be filled and sanded smooth for neat appearance.

C. To remove oils and dirt, to form a chemically and anodically neutral conversion coating to improve the finish-to-metal bond, and to retard underfilm propagation of corrosion, all surfaces shall undergo a thorough pretreatment process comprised of a fully automated system of cleaning, rinsing, phosphatizing, sealing, drying, and cooling before any protective coatings are applied. By utilizing an automated pretreatment process, the enclosure shall receive a highly consistent thorough treatment, eliminating fluctuations in reaction time, reaction temperature, and chemical concentrations.

D. After pretreatment, protective coatings shall be applied that shall help resist corrosion and protect the steel enclosure. To establish the capability to resist corrosion and protect the enclosure, representative test specimens coated by the enclosure manufacturer's finishing system shall satisfactorily pass the following tests:

1. 4000 hours of exposure to salt-spray testing per ASTM B 117 with:

    a. Underfilm corrosion not to extend more than 1/32" from the scribe as evaluated per ASTM D 1645, Procedure A, Method 2 (scraping); and
    b. Loss of adhesion from bare metal not to extend more than 1/8" from the scribe.

2. 1000 hours of humidity testing per ASTM D 4585 using the Cleveland Condensing Type Humidity Cabinet with no blistering as evaluated per ASTM D 714.
3. 500 hours of accelerated weathering testing per ASTM G 53 using lamp UVB-313 with no chalking as evaluated per ASTM D 659, and no more than 10% reduction of gloss as evaluated per ASTM D 523.
4. Crosshatch adhesion testing per ASTM D 3359 Method B with no loss of finish.
5. 160-inch-pound impact adhesion testing per ASTM D 2794 with no chipping or cracking.
6. Oil resistance testing consisting of a 72-hour immersion bath in mineral oil with no shift in color, no streaking, no blistering, and no loss of hardness.
7. 3000 cycles of abrasion testing per ASTM 4060 with no penetration to the substrate.
8. Certified test abstracts substantiating the above capabilities shall be furnished upon request.

E. After the finishing system has been properly applied and cured, welds along the enclosure bottom flange shall be coated with a wax-based anticorrosion moisture barrier to give these areas added corrosion resistance.

F. A resilient closed-cell material, such as PVC gasket, shall be applied to the entire underside of the enclosure bottom flange to protect the finish on this surface from scratching during handling and installation. This material shall isolate the bottom flange from the alkalinity of a concrete foundation to help protect against corrosive attack.

G. After the enclosure is completely assembled and the components (switches, fuses, bus, etc.) are installed, the finish shall be inspected for scuffs and scratches. Blemishes shall be touched up by hand to restore the protective integrity of the finish.

H. The finish shall be olive green, Munsell 7GY3.29/1.5.

2.10 CORROSION RESISTANCE

A. To guard against corrosion, all hardware (including door fittings, fasteners, etc.), all operating-mechanism parts, and other parts subject to abrasive action from mechanical motion shall be of either nonferrous materials, or galvanized or zinc-nickel-plated ferrous materials. Cadmium-plated ferrous parts shall not be used.

2.11 INTERRUPTER SWITCHES

A. Interrupter switches shall have a two-time duty-cycle fault-closing rating equal to or exceeding the short-circuit rating of the pad-mounted gear. These ratings define the ability to close the interrupter switch twice against a three-phase fault with asymmetrical current in at least one phase equal to the rated value, with the switch remaining operable and able to carry and interrupt rated current. Tests substantiating these ratings shall be performed at maximum voltage with current applied for at least 10 cycles. Certified test abstracts establishing such ratings shall be furnished upon request.

B. Interrupter switches shall be operated by means of an externally accessible 3/4" hex switch-operating hub. The switch-operating hub shall be located within a recessed stainless-steel pocket mounted on the side of the pad-mounted gear enclosure and shall accommodate a 3/4" deep-socket wrench or a 3/4" shallow-socket wrench with extension. The switch-operating-hub pocket shall include a padlockable stainless-steel access cover that shall incorporate a hood to protect the padlock shackle from tampering. Stops shall be provided on the switch-operating hub to prevent overtravel and thereby guard against damage to the interrupter switch quick-make quick-break mechanism. Labels to indicate switch position shall be provided in the switch-operating-hub pocket.

C. Each interrupter switch shall be provided with a folding switch-operating handle. The switch-operating handle shall be secured to the inside of the switch-operating-hub pocket by a brass chain. The folded handle shall be stored behind the closed switch-operating-hub access cover.

D. Interrupter switches shall utilize a quick-make quick-break mechanism installed by the switch manufacturer. The quick-make quick-break mechanism shall be integrally mounted on the switch frame, and shall swiftly and positively open and close the interrupter switch independent of the switch-operating-hub speed.

E. Each interrupter switch shall be completely assembled and adjusted by the switch manufacturer on a single rigid mounting frame. The frame shall be of welded steel construction such that the frame intercepts the leakage path which parallels the open gap of the interrupter switch to positively isolate the load circuit when the interrupter switch is in the open position.

F. Interrupter switch contacts shall be backed up by stainless-steel springs to provide constant high contact pressure.

G. Interrupter switches shall be provided with a single blade per phase for circuit closing including fault closing, continuous current carrying, and circuit interrupting. Spring-loaded auxiliary blades shall not be permitted. Interrupter switch blade supports shall be permanently molded in place in a unified insulated shaft constructed of the same cycloaliphatic epoxy resin as the insulators.

H. Circuit interruption shall be accomplished by use of an interrupter which is positively and inherently sequenced with the blade position. It shall not be possible for the blade and interrupter to get out of sequence. Circuit interruption shall take place completely within the interrupter, with no external arc or flame. Any exhaust shall be vented in a controlled manner through a deionizing vent.

I. Interrupter switches shall have a readily visible open gap when in the open position to allow positive verification of switch position.

J. Ground studs shall be provided at all switch terminals. Ground studs shall also be provided on the ground pad in each interrupter switch compartment and on the terminals and ground pad in any bus compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

K. Key interlocks shall be provided to guard against opening fuse-compartment door(s) unless all switches (series tap switch only, where furnished) are locked open.

L. Base-mounted distribution-class surge arresters, metal-oxide type rated 15 kv, shall be provided at all source switch terminals. As indicated on Contract Drawings.

2.12 FUSES

A. Solid-Material Power Fuses

1. Fuses shall be disconnect style, solid-material power fuses, and shall utilize refill-unit-and-holder or fuse-unit-and-end-fitting construction. The refill unit or fuse unit shall be readily replaceable and low in cost.

2. Fusible elements shall be nonaging and nondamageable so that it is unnecessary to replace unblown companion fuses on suspicion of damage following a fuse operation.
3. Fusible elements for refill units or fuse units rated 10 amperes or larger shall be helically coiled to avoid mechanical damage due to stresses from current surges.
4. Fusible elements, that carry continuous current, shall be supported in air to help prevent damage from current surges.
5. Each refill unit or fuse unit shall have a single fusible element to eliminate the possibility of unequal current sharing in parallel current paths.
6. Solid-material power fuses shall have melting time-current characteristics that are permanently accurate to within a maximum total tolerance of 10% in terms of current. Time-current characteristics shall be available which permit coordination with protective relays, automatic circuit reclosers, and other fuses.
7. Solid-material power fuses shall be capable of detecting and interrupting all faults whether large, medium, or small (down to minimum melting current), under all realistic conditions of circuitry, with line-to-line or line-to-ground voltage across the fuse, and shall be capable of handling the full range of transient recovery voltage severity associated with these faults.
8. All arcing accompanying operation of solid-material power fuses shall be contained within the fuse, and all arc products and gases evolved shall be effectively contained within the exhaust control device during fuse operation.
9. Solid-material power fuses shall be equipped with a blown-fuse indicator that shall provide visible evidence of fuse operation while installed in the fuse mounting.

B. Fuse-mounting jaw contacts shall incorporate an integral load interrupter that shall permit live switching of fuses with a hookstick.

1. The integral load interrupter housing shall be of a thermoplastic material.
2. The integral load interrupter shall be in the current path continuously. Auxiliary blades or linkages shall not be used.
3. Live switching shall be accomplished by a firm, steady opening pull on the fuse pull ring with a hookstick. No separate load-interrupting tool shall be required.
4. The integral load interrupter shall require a hard pull to unlatch the fuse to reduce the possibility of an incomplete opening operation.
5. Internal moving contacts of the integral load interrupter shall be self-resetting after each opening operation to permit any subsequent closing operation to be performed immediately.
6. Circuit interruption shall take place completely within the integral load interrupter with no external arc or flame.
7. The integral load interrupter and the fuse shall be provided with separate fault-closing contacts and current-carrying contacts. The fuse hinge shall be self-guiding and, together with the fault-closing contacts, shall guide the fuse into the current-carrying contacts during closing operations. Circuit-closing inrush currents and fault currents shall be picked up by the fault-closing contacts, not by the current-carrying contacts or interrupting contacts.
8. Integral load interrupters for fuses shall have a one-time duty-cycle fault-closing capability equal to the interrupting rating of the fuse, and a two-time duty-cycle fault-closing capability of 13,000 amperes rms asymmetrical at 14.4 kV or 25 kV. The duty-cycle fault-closing capability defines the level of available fault current

into which the fuse can be closed the specified number of times (once or twice), without a quick-make mechanism and when operated vigorously through its full travel without hesitation at any point, with the integral load interrupter remaining operable and able to carry and interrupt currents up to the emergency peak-load capabilities of the fuse.

C. Fuse terminal pads shall be provided with a two-position adapter, making it possible to accommodate a variety of cable-terminating devices.

D. Ground studs shall be provided at all fuse terminals. One ground stud shall also be provided on the ground pad in each fuse compartment. The momentary rating of the ground studs shall equal or exceed the short-circuit ratings of the pad-mounted gear.

E. A fuse-storage compartment shall be provided in three source interrupter-switch compartment(s). Each fuse-storage compartment shall provide space for storing three spare fuse holders or fuse units with end fittings for solid-material power fuses, or one spare electronic power fuse holder.

F. Fuse sizes, ratings and characteristics shall be coordinated with the existing medium voltage (12 kV) electrical distribution system.

2.13 LABELING

A. Hazard-Alerting Signs

1. All external doors shall be provided with "Warning—Keep Out—Hazardous Voltage Inside—Can Shock, Burn, or Cause Death" signs.
2. The inside of each door shall be provided with a "Danger—Hazardous Voltage—Failure to Follow These Instructions Will Likely Cause Shock, Burns, or Death" sign. The text shall further indicate that operating personnel must know and obey the employer's work rules, know the hazards involved, and use proper protective equipment and tools to work on this equipment.
3. Interrupter switch compartments shall be provided with "Danger" signs indicating that "Switches May Be Energized by Backfeed."
4. Fuse compartments shall be provided with "Danger" signs indicating that "Fuses May Be Energized by Backfeed."
5. Barriers used to prevent access to energized live parts shall be provided with "Danger—Keep Away—Hazardous Voltage—Will Shock, Burn, or Cause Death" signs.

B. Nameplates, Ratings Labels, and Connection Diagrams

1. The outside of each door (or set of double doors) shall be provided with a nameplate indicating the manufacturer's name, catalog number, model number, date of manufacture, and serial number.
2. The inside of each door (or set of double doors) shall be provided with a ratings label indicating the following: voltage ratings; main bus continuous rating; short-circuit ratings (amperes rms symmetrical and Mva three-phase symmetrical at rated

nominal voltage); the type of fuse and its ratings including duty-cycle fault-closing capability; and interrupter switch ratings including duty-cycle fault-closing and short-time (momentary, amperes rms asymmetrical and one-second, amperes rms symmetrical).

3. A three-line connection diagram showing interrupter switches, fuses with integral load interrupter, and bus along with the manufacturer's model number shall be provided on the inside of each door (or set of double doors), and on the inside of each switch-operating-hub access cover.

2.14 ACCESSORIES

A. End fittings or holders, and fuse units, refill units for original installation, as well as one spare fuse unit, refill unit, or interrupting module for each fuse mounting shall be furnished.

B. A fuse handling tool as recommended by the fuse manufacturer shall be furnished.

C. A total of three (3) sets of three grounding jumpers each 3 feet in length shall be provided complete with a storage bag for each set.

D. A voltage tester with audiovisual signal capability and batteries, shotgun clamp–stick adapter, and storage case shall be provided.

E. A shotgun clamp stick (6'- 5-1/2") in length shall be provided complete with a canvas storage bag.

G. All cable termination points shall be supplied with a bronze body, tin plated, two bolt, connector suitable for #2 AWG solid through 500 KCMIL stranded copper or aluminum.

PART 3 - EXECUTION

3.1 MISCELLANEOUS INSTALLATION REQUIREMENTS:

A. A driven-ground rod system consisting of copper-clad steel or stainless steel ground rods shall be installed in the substation area. The ground rods shall be interconnected with 4/0 bare copper of copper-clad wire and shall have a measured ground resistance of not more than 5 ohms.

B. All noncurrent carrying metal parts of the substation shall be connected to the ground system. The switchgear ground bus shall be connected at a minimum of two places to the ground system with #4/0 AWG bare copper wire.

C. Exothermic joints shall be used for all connections below grade. Double-bolted compression type connectors shall be used for above-grade ground connections to equipment ground bus.

3.2 INSPECTION AND TEST REQUIREMENTS

A. A Certificate of Electrical Inspection covering all new main substations and reconnection of a modified or relocated existing main substation shall be obtained from the proper Code enforcing authority and a copy forwarded to the Engineer and the local utility company before such equipment may be energized.

B. Visually inspect switchgear for evidence of damage and verify that surfaces are ready to receive work.

C. Visually inspect to confirm all items and accessories are in accordance with Specifications and Drawings.

D. Verify field measurements and clearances are as shown on the Drawings.

E. Verify that required utilities are available, in proper location, and ready for use.

F. Beginning of installation means installer accepts existing surface conditions.

G. Visually inspect for physical damage.

H. Perform mechanical operator tests in accordance with manufacturer's instructions. Check blade alignment and arc interrupter operations.

I. Check torque of all bolted connections, including cable terminations.

J. Tough up paint all chips and scratches with switchgear manufacturer-supplied paint and leave remaining paint (one pint minimum) with Owner.

3.3 LOCKS

A. Provide padlocks on all gear when installed. Padlocks shall match Owner's present padlocks and be keyed per Owner's requirements.

B. Provide Owner with two keys for each padlock.

C. All units shall be furnished with enough padlocks to completely lock each unit.

END OF SECTION

DIVISION 26
SECTION 262200
TRANSFORMERS
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SECTION 262200 – 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes dry-type distribution and high-harmonic/non-linear load transformers rated 1000 V, and less.

1.3 SUBMITTALS

A. Product Data: Include data on features, components, ratings, dimensions, weight, and performance for each type of transformer specified. Include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features.

B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

D. Qualification Data: For firms and persons specified in *Quality Assurance* Article.

E. Field Test Reports: Indicate and interpret test results for tests specified in Part 3 of this Section.

F. Maintenance Data: For transformers to be included in the maintenance manuals specified in Division 01.

G. Project Record Documents: Record actual transformer locations.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content.

Include statement indicating costs for each product having recycled content. See specification 018113.

2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to requirements specified in Division 01 Section "Quality Control", an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907; or shall be a full-member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide transformers specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labele*d: As defined in NFPA 70, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit throughout periods during which equipment is not energized and is not in a space that is continuously under normal control of temperature and humidity.

B. Store and protect equipment in a dry location with uniform temperature. Cover ventilation openings to keep dust out.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers: No other manufacturers are acceptable.

1. Square D Company (Basis of Design).
2. Eaton Corp; Cutler-Hammer Products.
3. Siemens Energy & Automation, Inc.

2.2 TRANSFORMERS, GENERAL REQUIREMENTS

A. Description: Factory-assembled and tested, air-cooled units of types specified, designed for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices, except for taps.

D. Coil Conductors: Individual insulate secondary conductors and arrange to minimize hysteresis and eddy current losses at harmonic frequencies.

E. Internal Coil Connections: Brazed or pressure type.

F. Efficiency: All transformers shall meet or exceed efficiency requirements of NEMA TP1- "Guide for Determining Energy Efficiency for Distribution Transformers" when tested per NEMA TP2 - "Standard Test Method for Measuring the Energy Consumption of Distributing Transformers."

G. Enclosure: Class complies with NEMA 250 for the environment in which installed. Comply with NEMA ST 20.

H. Nameplates: Include transformer connection data and overload capacity based on rated allowable temperature rise.

I. Basic Impulse Level: 10 kV for transformers less than 300 kVA.

2.3 GENERAL PURPOSE TRANSFORMERS

A. General

1. Dry-Type distribution transformers for general loads, single and/or three-phase, with primary and secondary voltages of 600 V and less and capacity ratings 15kVA through 750kVA.

B. Standards

1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.
2. Conform to the requirements of ANSI/NFPA 70.
3. Transformers are to be manufactured and tested in accordance with NEMA ST20 and UL 1561.
4. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO 9001:1994 SIC3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees C UL component recognized insulation system.
2. Transformers 15kVA and larger shall be 150 degrees C temperature rise above 40 degrees C ambient.
3. Transformers 25kVA and larger shall have a minimum of 4 – 2.5% full capacity primary taps. Exact voltages and taps to be as designated on the plans or the transformer schedule.
4. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient temperature.

E. Construction

1. Transformer coils shall be of continuous wound construction and shall be impregnated with nonhygroscopic, thermosetting varnish.
2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturated point to prevent core overheating. Cores for transformers greater than 500kVA shall be clamped utilizing insulated bolts through the core laminations to ensure proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure, but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.
3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.

F. Sound Levels

1. Sound levels shall be warranted by the manufacturer not to exceed the following: 15 to 50 KVA - 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to 1000kVA – 64dB; 1001 to 1500kVA – 65dB; 1501 to 2000kVA – 66dB

2.4 HIGH HARMONIC LOAD (K-RATED) TRANSFORMERS

A. General

1. Dry type distribution transformers for non-linear loads, single and/or three phase, primary and secondary voltage of 600V and less and capacity ratings of 15kVA through 750kVA.

B. Standards

1. Transformers 750kVA and smaller shall be listed by Underwriters Laboratories.
2. Conform to the requirements of ANSI/NFPA 70.
3. Transformers are to be manufactured and tested in accordance with NEMA ST20 and UL1561.
4. Transformers shall be low loss type with minimum efficiencies per NEMA TP1 when operated at 35% of full load capacity. Efficiency shall be tested in accord with NEMA TP2.

C. Manufacturers

1. Approved manufacturers shall be registered firms in accordance with ISO9001:1994 SIC 3612 (US); which is the design and manufacture of low voltage dry type power, distribution and specialty transformers.

D. Ratings Information

1. All insulating materials are to exceed NEMA ST20 standards and be rated for 220 degrees C UL component recognized insulation system.
2. Neither the primary nor the secondary temperature shall exceed 220 degree C at any point in the coils while carrying their full rating of non-sinusoidal load.
3. Transformers are to be UL listed and labeled for K-13 as defined as the sum of fundamental and harmonic 1 h per UL 1561.
4. Transformers evaluated by the UL K-factor evaluation shall be listed for 115 degrees C average temperature rise. K-factor listed transformers rated at 150 degrees C rise shall not be acceptable.
5. K-factor rated transformers shall have an impedance range of 3% to 5% and shall have a minimum reactance of 2% in order to help reduce neutral current when supplying loads with large amounts of third harmonic current.
6. Transformers 15kVA and larger shall have a minimum of 6 – 2.5% full capacity primary taps for 480V primaries and a minimum of 2 – 5% fully capacity taps for 208V primaries. Exact voltage and taps to be as designated on the plans or the transformer schedule.
7. The maximum temperature of the top of the enclosure shall not exceed 50 degrees C rise above a 40 degrees C ambient temperature.

E. Construction

1. Transformer coils shall be of continuous wound construction and shall be impregnated with nonhygroscopic, thermosetting varnish.
2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. The core laminations shall be clamped together with steel angles. The completed core and coil shall be bolted to the base of the enclosure but isolated by

means of rubber vibration absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.

3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The entire enclosure shall be finished utilizing a continuous process consisting of degreasing, cleaning and phosphatizing, followed by electrostatic deposition of polymer polyester powder coating and baking cycle to provide uniform coating of all edges and surfaces. The coating shall be UL recognized for outdoor use. The coating color shall be ANSI 49.
5. Transformers shall be supplied with quality, full width electrostatic shields resulting in a maximum effective coupling capacitance between primary and secondary of 33 picofarads. With transformers connected under normal, loaded operating conditions, the attenuation of line noise and transients shall equal or exceed the following limits:

    a. Common Mode: 0 to 1.5kHZ – 120dB; 1.5kHZ to 10kHZ – 90dB; 10kHZ to 100kHZ – 65dB; 100kHZ to1MHZ – 40dB
    b. Transformer Mode: 1.5kHZ to 10kHZ – 52dB; 10kHZ to 100kHZ – 30dB; 100kHZ to 1MHZ 30dB

6. Sound Levels

    a. Sound levels shall be warranted by the manufacturer not to exceed the following:
        1). 15 to 50kVA – 45dB; 51 to 150kVA – 50dB; 151 to 300kVA – 55dB; 301 to 500kVA – 60dB; 501 to 700kVA – 62dB; 701 to1000kVA – 64dB.

2.5 CONTROL AND SIGNAL TRANSFORMERS

A. Units comply with NEMA ST 1 and are listed and labeled as complying with UL 506.

B. Ratings: Continuous duty. If rating is not indicated, provide capacity exceeding peak load by 50 percent minimum.

C. Description: Self-cooled, 2 windings.

2.6 FINISHES

A. Indoor Units: Manufacturer's standard paint over corrosion-resistant pretreatment and primer.

B. Outdoor Units: Comply with ANSI C57.12.28.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with safety requirements of IEEE C2.

B. Arrange equipment to provide adequate spacing for access and for circulation of cooling air.

C. Identify transformers and install warning signs according to Division 26 Section “Electrical Identification”.

D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Install transformers in accordance with NECA SI, and Manufacturer's published instructions, at locations as indicated on the Drawings.

1. Use Manufacturer-approved mounting brackets for transformers supported from building structure.
2. Securely anchor transformers to concrete housekeeping pads for floor-mounted transformers.
3. Provide working clearances in conformance with NFPA 70.
4. Provide primary and secondary protection using fuses or circuit breakers as indicated on the Drawings.

F. Set transformers plumb and level.

G. Use minimum two (2) foot length flexible conduit for connections to transformer case. Make conduit connections to side panel of enclosure.

H. Mount transformers on vibration isolating pads suitable for isolating transformer noise from building structure.

I. Provide minimum 4-inch high concrete pad for floor-mounted transformers. Refer to Division 26 Section, “Common Work Results for Electrical” for installation requirements.

J. Verify mounting supports are properly sized and located, including concealed bracing in walls.

3.2 GROUNDING

A. Separately Derived Systems: Comply with NFPA 70 requirements for connecting to grounding electrodes and for bonding to metallic piping near the transformer. The neutral point of each transformer secondary shall be bonded to the grounding system.

B. Comply with Division 26 Section “Grounding and Bonding” for materials and installation requirements.

C. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Provide services of an independent electrical testing agency to perform tests on installations made under this section.

B. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

C. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed *Satisfactory Test* label to tested component.

D. Schedule tests and provide notification at least 7 days in advance of test commencement.

E. Report: Submit a written report of observations and tests. Report defective materials and installation.

F. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions. Comply with IEEE C57.12.91 for test methods and data correction factors.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values or, if not available, those specified in UL 486A and UL 486B.
3. Insulation Resistance: Perform megohmmeter tests of primary and secondary winding to winding and winding to ground.

    a. Minimum Test Voltage: 1000 V, dc.
    b. Minimum Insulation Resistance: 500 megohms.
    c. Duration of Each Test: 10 minutes.
    d. Temperature Correction: Correct results for test temperature deviation from 20 degrees C standard.

G. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

3.4 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.5 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

C. Adjust buck-boost transformer connections to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility.

D. Occupancy Adjustments: When requested within twelve (12) months of date of Substantial Completion, provide on-site assistance in readjusting transformer tap settings to suit actual occupied conditions. Provide up to two (2) visits to Project site for this purpose without additional cost.

1. Voltage Recordings: Contractor performed. Provide up to 48 hours of recording on the low-voltage system of each medium-voltage transformer.
2. Point of Measurement: Make voltage recordings at load outlets selected by Owner.

END OF SECTION

DIVISION 26
SECTION 262412
SOLAR PHOTOVOLTAIC SYSTEM
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SECTION 262412 – SOLAR PHOTOVOLTAIC 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.

B. Requirements of the following Division 26 Sections apply to this Section:

1. "Common Work Results for Electrical"
2. "Conductors and Cables"
3. "Grounding and Bonding"
4. "Raceways and Boxes"
5. "Electrical Identification"
6. "Enclosed Switches and Circuit Breakers"
7. "Lightning Protection"
8. "Metering"
9. "Electrical Firestopping"

C. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 ALTERNATES

A. Refer to Division 01 Section "Alternates" for description of Alternates that affect the work in this Section.

1.3 SUMMARY

A. This Section includes:

1. All materials required for the specified grid-interactive solar photovoltaic system, including photovoltaic modules, mounting system, inverters, disconnects, string combiner boxes, monitor/display system equipment, AC wiring, DC wiring, and conduit.
2. Complete installation of solar photovoltaic system, including interconnection with the building's electrical service and solar-specific monitoring.

B. All electrical components, including over-current protection, disconnects, surge suppression devices, conduit, wiring and terminals must have UL or equivalent listing and have appropriate voltage, current and temperature ratings for the application. Special attention must be given to appropriate ratings for components used in DC circuits.

1.4 SYSTEM DESCRIPTION

A. The system shall be a grid-interactive, battery-less, solar photovoltaic power system, connected to the building's electrical system, and generating in parallel with the utility grid.

B. The system shall have a nominal rated capacity as indicated on the Contract Documents.

C. The photovoltaic modules shall be attached to the roof using a mounting system as specified herein.

D. The system shall have web-based monitoring that is capable of recording and displaying (via the internet) PV system parameters.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer data for all pertinent components (PV modules, mounting system, combiner boxes, inverters, monitoring equipment, circuit breakers, conductors, conduits, disconnect switches, etc…).

B. Equipment Certifications: Submit pertinent equipment certifications, specifically inverters being certified to IEEE-929, IEEE-1547, UL1741, and UL1998.

C. Maintenance Data: To be included in Maintenance Manuals specified in Division 01 and Division 26 Sections.

D. Warranties: Special warranties as specified herein.

E. Installer Certifications: Submit proof of Solar PV Installer Certification as specified herein.

F. Project Record Documents: Accurately record the following: Actual locations of PV modules, mounting/support system, inverters, bonding connections, and routing of system conductors in Project Record Documents.

1.6 SHOP DRAWINGS:

A. Submit shop drawings indicating PV module layout, mounting system attachment layout, mounting system ballast layout, and wiring layout.

B. Electrical schematics and diagrams showing all major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, conduit routing, roof penetration(s), connection to surge suppression devices at the inverters, and the inverters' interface with the utility grid.

C. Electrical schematics and diagrams showing data acquisition/monitoring system.

D. Show proposed labels as required by the National Electrical Code. Note where labels are to be located, as well as approximate dimensions of each label.

E. At project completion e-mail the monthly energy production to the Engineer for a minimum one (1) year duration.

1.7 WARRANTY

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

B. Special Warranty: Written warranty, executed by Manufacturer, agreeing to repair or replace components of PV modules, inverters, monitoring components that fail in materials or workmanship within specified warranty period.

C. Warranty Period:

1. Workmanship: Two (2) years from date of Substantial Completion.
2. Modules: See *Products*, this Section.
3. Inverters: See *Products*, this Section.
4. Solar Array Mounting System: See *Products*, this Section.
5. Data Acquisition/Mounting System: See *Products*, this Section.

1.8 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 *National Electrical Code.*

B. Electrical components shall be listed and labeled by UL, ETL, CSA or other approved, nationally recognized testing and listing agency that provides third-party certification follow-up services.

C. Testing Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7, or a full member company of the *International Electrical Testing Association* (NETA).

D. Installation Standard: Installation shall meet or exceed the *National Electrical Contractors Association* (NECA) Standard of Installation.

E. Manufacturer's Qualifications:

1. The manufacturer shall not have had less than ten (10) years experience in manufacturing products specified herein.
2. The manufacturer must certify in writing all components supplied have been produced in accordance with an established quality assurance program.

F. Installer Qualifications:

1. Installer must be a factory-trained manufacturer's authorized representative/installer with not less than five (5) years experience in the installation of solar photovoltaic systems of this size and conformation.
2. Installer shall have the following qualifications:

    a. *North American Board of Certified Energy Practitioners* (NABCEP) certified for Solar PV Installation.

G. Installation must comply with the local utility company's Net Metering Agreement.

H. Utilize equipment that is listed for use with solar photovoltaic systems, where appropriate.

1.9 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. All material is to be delivered to the work site in original factory packaging to avoid damage.

B. Upon delivery to the work site, all components shall be protected from the elements by a shelter or other covering.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to, the following:

1. Photovoltaic (PV) Modules:

    a. Provided by Owner.

2. Inverters:

    a. Fronius USA LLC (Basis of Design)
    b. SMA America
    c. Power-One/Magnetek
    d. PV Powered
    e. Satcon Power Systems
    f. Solectria Renewables
    g. KACO

3. Roof Penetrating Solar Array Mounting System:

    a. Sunlink (Basis of Design)
    b. Schletter

4. Data Acquisition/Monitoring System:

a. Fronius USA LLC (Basis of Design)
b. Power-One/Magnetek
c. Fat Spaniel Technologies, Inc.
d. Satcon Power Systems – PV View Plus
e. Solectria Renewables – Solren View

2.2 PHOTOVOLTAIC (PV) MODULES

A. Supplied by Owner.

1. Manufacturer/Model #: Motech Industries, Inc.: MTPVp-235W-MSB

2.3 INVERTERS

A. Provide inverters as indicated on the Contract Documents.

B. Designed specifically for utility grid interconnection of photovoltaic arrays and shall be capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels for the size and type of array used.

C. Shall be compliant with *IEEE Std. 929-2000 Recommended Practice for Utility Interface of Photovoltaic Systems* and *UL1741 Standard for Static Inverters and Charge Controllers for Use in Photovoltaic Power Systems*.

D. Inverters shall be mounted in an enclosure suitable for continuous operation at ambient temperature of -20 to +50 degrees C (-4 to 122 degrees F) with relative humidity to 95 percent condensing. All high voltage components within enclosure shall be isolated. The complete unit shall be UL approved and UL labeled.

E. Inverters shall have the following basic features:

1. Internal Islanding Protection: Frequency, voltage, and impedance detection methods.
2. Integral MPPT (Maximum Power Point Tracking) Function.
3. DC reverse polarity protection by means of internal diode.
4. Ground fault protection in accordance with *NEC Article 690*. Ground-fault protection device must be capable of detecting array ground faults, shunting the fault current to ground, and disabling the array until the fault has been cleared.
5. Integrated, lockable and load breakable DC disconnect to provide a positive disconnect between the inverter and incoming source circuit(s) from PV modules.
6. Main output AC disconnect to provide a positive disconnect between the inverter and all phases of the outgoing AC line.
7. Internal DC & AC surge protection to 6 kV.
8. Internal temperature overload protection shall automatically de-rate power output and shut off inverter to prevent over-heating.

F. Shall not operate without the line voltage present. The inverter shall sense a “loss of line” (utility) condition and shall automatically disconnect from the line within two seconds

after loss of line. The inverter shall restart automatically after restoration of line voltage and frequency for at least five minutes.

2.4 SELF-BALLASTED SOLAR ARRAY MOUNTING SYSTEM

A. Shall be constructed of 0.063" (nominal thickness) mill certified sheet aluminum.

B. Angle of inclination shall be customizable and shall be as indicated on the Drawings.

C. Shall be a ballasted, non-penetrating system. Concrete blocks shall be used as the ballast and shall be set inside on the base of the system at a pre-determined spacing based on local wind load criteria and manufacturer's recommendation. Coordinate loads with Structural Engineer. If the roof is ballasted type, roof ballast material may be used in place of concrete blocks.

D. Sections shall be set end to end to create the desired row length for the solar array being assembled.

E. Rows shall be tied together using aluminum "T" angles, running perpendicular to the rows every 10'-0" on center.

F. Shall have ventilated end caps, as well as stamped ventilation louvers on the front and back sides.

G. Structure shall be elevated from roof surface by means of 1" thick strips of polystyrene insulation adhered to bottom of support structure.

H. All fasteners/hardware shall be stainless steel.

I. Shall meet *ASCE 7-05* wind loading criteria up to 120 mph winds and shall be *UL* listed under *UL 21MP* for *Photovoltaic Power System Accessories*.

J. Warranty: Shall remain free of defects in materials and workmanship under normal installation, application, use and service conditions, for a period of twenty years from date of original purchase.

2.5 DATA ACQUISITION/MONITORING SYSTEM

A. Data acquisition system for monitoring and collection of performance data for photovoltaic energy system shall provide real-time and historical data of photovoltaic energy system including energy production. Local weather data/conditions shall be obtained from interfacing with building's automatic temperature control system.

B. The data network shall operate as a ring-shaped bus system. A single data link between the individual components enables communication between one or more inverters and datalogging/monitoring components.

C. The system shall have computer-based and web-based monitoring that is capable of recording and displaying PV system parameters via the internet and manufacturer's software.

D. Provide all required system components, including, but not limited to:

1. Data-logging device
2. Inverter communication card(s)
3. Software
4. Public display(s)
5. Power adapters, power cords, wiring, connectors, device faceplates, etc…
6. Network connection via Ethernet or B02.11B, or approved equal.

E. Verify compatibility of all components to ensure the complete monitor/display system will function properly.

F. Submittals: Provide wiring diagrams and installation guide.

G. Data-Logging Device

1. Records data for the entire photovoltaic system.
2. Equipped with three data interfaces:

    a. Two for direct data transmission to a PC (RS232 and USB)
    b. One for remote PC data queries via modem and telephone line (RS232)

3. Capable of recording data transmitted from the total number of inverters shown on the Drawings.
4. Can be interfaced into existing network structures via an Ethernet interface, providing the following features:

    a. Full setting options and data preparation for the PV system onsite via a PC.
    b. Multi-user capability within the local network. Several users can access important system information simultaneously via a separate website – using a browser that is independent of the operating system.
    c. Real-time data and archived PV system data can be accessed via the internet and manufacturer's online service/software.

5. The data acquisition system shall interface with the automatic temperature control (ATC) system furnished under Division 23. The data logger shall support standard communication protocols such as: Modbus RTU, Modbus TCP, Ethernet TCP/IP, HTMC, FTP, SNMP, and have communication interfaces such as: RJ-45 10/100 base T local configuration port (Local Web Server Connection), RS-485, RS-485 Modbus RTU Slave/master port. Minimum information to be transmitted to the Division 23 ATC system are: instantaneous AC voltage, instantaneous AC current, instantaneous kW, daily kW, daily kWh, weekly kW, weekly kWh, monthly kW, monthly kWh, yearly kW, yearly kWh.

H. Inverter Communication Card(s)

1. Communicates within the inverter via internal network.
2. Provides the data link from the inverter to associated datalogging/monitoring components via RS485 interface.
3. Provides galvanic isolation between the photovoltaic system and the inverter.

4. Receives power via the line side of the inverter to ensure that the datalogger will be able to record all data regardless of state of inverter (on/off).
5. Equipped with switched-mode power supply and can be used with several supply voltages.
6. LED indicator on front of communication card shall indicate whether the card is receiving power properly.

I. Public Display

1. Public Display furnished and installed under Division 23 Section "Instrumentation and Control of HVAC and Plumbing System". See the same for detailed information.

2.6 NET ENERGY METER

A. Basis-of-Design: E-Mon D-Mon Green Class Net Meter.

B. Meter shall be fully electronic with digital 8-digit LCD display without multiplier.

C. Meter shall provide rate of consumption indication and also a segment test button (CPU) to ensure integrity of the display.

D. Meter shall provide load profiling data including:

1. Delivered kWh
2. Delivered kVARh
3. Received kWh
4. Real-time readings of Power Factor, kW, kVA, kVAR, Amps per phase, Volts per phase, and frequency.

E. Meter shall provide a load indicator to indicate real-time consumption levels for field testing and certification.

F. Meter shall be equipped with current sensor diagnostic indicator for installation verification.

G. Meter shall be enclosed in a heavy-duty steel enclosure suitable for indoor installation, equipped with a locking method to prevent unauthorized access.

H. Meter shall be UL Listed/CUL Listed, certified by a nationally recognized independent test facility to ANSI C12.1 and C12.16 specifications with split-core current sensors.

I. Meter shall be provided with non-volatile memory to maintain reading during power outages.

J. Meter shall use 0-2 volt output current sensors to allow paralleling and/or mounting up to 500 feet from the meter. Sensors shall be of split-core configuration to allow installation without powering down. Sensors shall be rated for amperage sufficient for load being metered.

K. Meter shall be capable of paralleling up to three (3) sets of current sensors for cumulative readings of multiple loads fed by a common transformer.

L. Meter shall be provided with the following communication options:

1. Terminal block for fixed-value pulse output of delivered kWh.
2. Ethernet Communication (for use with Energy Software).

2.7 CONDUCTORS

A. DC conductors:

1. Copper, rated 90 degrees Celsius, type USE-1/RHW-2
2. Red jacket color for positive conductors, white jacket color for negative conductors and green jacket color for grounding conductors.
3. All other restrictions of Division 26 Section, "Conductors and Cables" apply.
4. Shall be compliant with UL 4703, *Photovoltaic Wire.*

B. AC conductors

1. Refer to Division 26 Section, "Conductors and Cables".

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work.

B. By beginning work, conditions are accepted with the responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

A. Install photovoltaic system in strict accordance with manufacturers' written instructions.

B. Install components according to 2008 National Electrical Code Article 690 – *Solar Photovoltaic Systems* and 2008 National Electrical Code Article 705 – *Interconnected Electric Power Production Services.*

C. Size DC source circuit conductors. Ampacity calculations must take into account appropriate de-ratings as required. All conductors in the system are subject to a 125% NEC de-rate, and all DC source circuit conductors and overcurrent devices must include an additional 125% de-rate for solar radiation enhancement. Appropriate temperature de-ratings for conductors used in module junction boxes must be considered for peak module operating temperatures, as well as de-ratings for instances where more than three current-carrying conductors are enclosed in a conduit.

D. Voltage drop in array DC source circuits shall be limited to no more than 1% due to losses in conductors and no more than 2% including losses through all fuses, blocking diodes and termination points.

E. All overcurrent devices shall have trip ratings no greater than the de-rated ampacity of the conductors that it protects.

F. All series connected strings of modules must include a series fuse as required by UL and NEC to prevent wiring to other system components. Parallel connections of modules in individual source circuits are not permitted.

G. All series connected strings of modules must also include a blocking diode to prevent reverse currents. These diodes shall have a low voltage drop to meet the requirements above, and have voltage and current ratings (at temperature) at least twice the open-circuit voltage and short-circuit ratings of the source circuits.

H. Parallel strings of modules shall have individual string circuit protection as specified in Article 690.9 (A) of the 2008 National Electrical Code.

I. The PV modules shall be grounded in compliance with Article 690 of the 2008 National Electrical Code.

J. Tighten all mounting hardware and electrical terminations to manufacturer recommended torque specifications.

K. Wiring located on the exterior of the roof must be secured or protected in such a way that will not lead to abrasion or damage of the wire due to wind, ice, or precipitation.

L. All terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered, or taped connections are not permitted for the field-installed wiring. Proper torque specifications should be provided for all of the required field connections.

M. All module frames, mounting/support structures, metal enclosures, panelboards, and inverters shall be provided with connections for bonding to a common grounding conductor and terminating at the ground rod at the utility service entrance point. Under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

N. Provide the mechanical hardware for mounting the photovoltaic arrays, and all other hardware required for assembling the photovoltaic modules and support structures. All hardware/fasteners shall be stainless steel to prevent corrosion. Provide all hardware for mounting the inverters, including unistrut framing support and painted fire resistant plywood backboards.

O. Minimize the risk from exposed fasteners, sharp edges, and potential damage to the modules, support structure, and roof.

P. The PV array, including modules, hardware, and attachments shall be able to withstand wind loads as indicated on the Drawings and must comply with all existing local and national codes. If there is a discrepancy, whichever value is more stringent shall apply.

Q. Spacing between individual modules shall be kept to a minimum and shall create a uniform array appearance.

R. Where possible, all mechanical hardware, conduit, junction boxes and other equipment shall be concealed beneath and/or behind the array, or concealed within the support structure framing.

S. Coordinate monitoring equipment installation with Division 23 Contractor.

T. Verify and document proper function including string voltages, anti-islanding, and system output.

U. Install components plumb and level, accurately fitted, free from distortion or defects.

V. Separate dissimilar metals and use gasketed fasteners, isolation shim, or isolation tape to eliminate possibility of corrosive or electrolytic action between metals.

W. Exercise care when installing components so as not to damage finish surfaces. Temporarily store panels on roof on top of protection material such as plywood.

X. Remove all protective masking from material immediately after installation.

Y. Coordinate conduit penetrations through roof with Roofing Contractor.

Z. Provide and coordinate rigging equipment, crane, and associated devices. Comply with OSHA requirements. Provide wagons with rubber tires or similar devices for transporting panels across the roof.

AA. Provide all materials that may be required by the roofing material manufacturer in order to maintain the roof's warranty. Any installations that void the warranty shall be repaired until deemed acceptable by the roofing manufacturer, at no additional cost to the Owner. Coordinate installation with roofing contractor.

BB. Circuits inside buildings/structures: PV system dc conductors (source and output) run inside a building/structure must be contained in a metal raceway. Refer to Division 26 Section "Raceways and Boxes" for conduit/raceway application schedule.

CC. Circuits Beneath Roofs: Wiring methods cannot be located within ten (10) inches of the roof decking or sheathing, except where located directly below the roof surface covered by PV modules and associated equipment, and must be run perpendicular to the roof penetration point.

3.3 IDENTIFICATION

A. Install permanent plaques and labels for identification as required by the National Electrical Code and by the local utility company. Refer to Division 26 Section, "Electrical Identification", for basic material requirements.

B. Operating Instructions: Frame printed operating instructions for inverters, including emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on wall adjacent to inverters.

C. Conductors

1. PV System conductors must be identified by separate color coding, marking tape, tagging, or other approved means and grouped as follows:

    a. PV Source Circuits – identified at points of termination, connection, and splices.
    b. PV Output and Inverter Circuits – Identified at points of termination, connection, and splices.
    c. Grouping – Where the conductors of more than one PV system occupy the same junction box or raceway with removable cover, the ac and dc conductors of each system must be grouped together by cable ties at intervals not to exceed six (6) feet.

2. Label all source circuit conductors with permanent labels, label type per Division 26, Section "Electrical Identification". Labeling scheme shall be as follows:

    A x SA y Sz +/-

    Where "x" is the array number, "y" is the subarray number (if applicable) and "z" is the string number. A plus or minus sign shall indicate if the conductor is the positive or negative conductor of the source circuit.

3. Raceways, wireways and enclosures containing PV source conductors must be marked "Photovoltaic Power Source" by labels or other approved permanent marking means. Marking must be visible after installation and appear on every section of the wiring system separated by enclosures, walls, partitions, ceilings, or floors. Spacing between labels/markings must not be more than ten (10) feet. Labels must be suitable for the environment in which they are being installed.
4. Refer to Division 26 Section "Electrical Identification" for labeling material requirements.

D. Equipment

1. Equipment for PV systems such as inverters, photovoltaic modules, source-circuit combiners, and charge controllers must be identified and listed for the application.
2. Where multiple utility-interactive inverters are located remote from each other, a directory is required at each dc PV system disconnecting means, at each ac disconnecting means, and at the main service disconnecting means showing the location of all ac and dc PV disconnecting means in the building/structure.

    a. A directory is not required where all PV system disconnecting means are grouped at the service disconnecting means.

3. A warning label must be installed on all utility-interactive inverter(s) stating the following: "WARNING – ELECTRICK SHOCK HAZARD – IF A GROUND-FAULT IS INDICATED, NORMALLY GROUNDED CONDUCTORS MAY BE UNGROUNDED AND ENERGIZED".
4. Warning labels must resist the environment for 25 to 40 years of system use and be suitable for the environment in which they are installed, and be installed so as to not void

equipment listing. If plastic labels are used, they should not be placed in direct sunlight, unless specifically manufactured as "sunlight-resistant".

5. A permanent plaque identifying the locations of the service and inverter ac disconnect(s) must be placed at the service and inverter ac disconnect(s) locations.
6. Each PV system disconnect must be permanently marked to identify it as the PV system disconnect.
7. For dc disconnects where line and load terminals will be energized when the switch is in the open position, a warning sign must be placed on the disconnect switch, stating the following: "WARNING – ELECTRIC SHOCK HAZARD DO NOT TOUCH TERMINALS – TERMINALS ON BOTH THE LINE AND LOAD SIDES MAY BE ENERGIZED IN THE OPEN POSITION".
8. A permanent label must be applied by the PV system installer at each PV system dc disconnecting means indicating the following:

    a. Rated Maximum Power-Point Current (Imp x number of combined paralleled source circuits).
    b. Rated Maximum Power-Point Voltage (Vmp x number of modules in each source circuit).
    c. Maximum System Voltage (Voc)
    d. Short-Circuit Current (Isc)

9. The point of interconnection of the PV system to ac power must be marked with the rated ac output current and nominal operating ac voltage.

    a. Line 1: "Panelboard is Energized from Two Sources of AC Power"
    b. Line 2: " Solar PV: _____A at _____V"
    c. Line 3: "Utility: _____A at _____V"

10. Install a permanent plaque at the service and the PV system ac disconnecting means identifying the location of the other system if not located at the same location.

3.4 PROTECTION

A. Protect installed components until completion of Project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

C. Protect roof surface from being punctured or otherwise damaged during installation of photovoltaic modules.

3.5 CORROSION PROTECTION

A. Corrosion resistance and durability of the mechanical hardware is crucial.

    1. Hardware/fasteners shall be stainless steel.
    2. The support system shall be constructed of aluminum as specified herein.

B. Ferrous metals, wood or plastic components are not acceptable, unless approved by the Engineer.

C. Galvanic corrosion shall be avoided.

3.6 LIGHTNING SURGE PROTECTION

A. Lightning surge protection must be provided for the photovoltaic array and other system components in accordance with the component manufacturer(s)' requirements. The lightning protection circuit must be bonded to the photovoltaic array and to its support structure.

B. Coordinate all work related to lightning surge protection with Lightning Protection System Contractor.

C. Provide lightning arrestor at each inverter and connect per manufacturer's instructions/wiring diagrams.

3.7 GROUNDING AND BONDING

A. PV system components must be grounded in strict accordance with 2008 National Electrical Code Article 690 – "Solar Photovoltaic (PV) Systems" and Article 250 – "Grounding and Bonding".

B. The negative conductor of a two-wire PV system operating at over 50V must be grounded. This "grounded conductor" must be identified in accordance with 2008 NEC Article 200.6 – "Means of Identifying Grounded Conductors".

C. PV systems with ground-fault protection that incorporates a system grounding connection, must not have an additional grounding connection.

D. Exposed metal parts of PV module frames, electrical equipment, raceways, and enclosures must be connected to an equipment grounding conductor of a type permitted in NEC Article 250 – "Grounding and Bonding".

E. An Equipment Grounding Conductor (EGC) must be installed between the PV array and associated equipment.

F. Devices listed for grounding metallic frames of PV modules and associated equipment can be used to bond exposed metal surfaces of PV modules and equipment to metal racks.

G. Metallic mounting racks used as an equipment grounding conductor must be identified as an equipment grounding conductor or have identified bonding jumpers/devices connected between the separate metallic racks and be connected to an equipment grounding conductor.

H. Devices and systems securing PV modules to metallic mounting racks that serve as an equipment grounding conductor must be identified for such purposes.

I. Devices listed for bonding metallic frames of PV modules can be used to bond PV modules to adjacent PV modules.

J. All conductors of a circuit, including the equipment grounding conductor, must be installed in the same raceway when leaving the vicinity of the array.

K. Equipment grounding conductors must be sized to the rating of the PV circuit overcurrent device in accordance with 2008 NEC Table 250.122 – "Sizing Equipment Grounding Conductor".

L. Exposed equipment grounding conductors sized 8 AWG and smaller subject to physical damage must be installed in a raceway.

M. Grounded PV systems constructed of dc PV modules must have the dc system grounded by one of the following methods:

1. Direct-Current Grounding Electrode: A grounding electrode conductor from the marked dc GEC point at the inverter to a dc separate grounding electrode sized no smaller than the largest ungrounded conductor.
2. Alternating-Current Grounding Electrode: A grounding electrode conductor sized in accordance with NEC run from the marked dc GEC point at the inverter to the ac grounding electrode.

3.8 POINT OF CONNECTION

A. Photovoltaic system output shall be connected in compliance with 2008 National Electrical Code Article 690.64 and Article 705.12.

1. All circuit breakers utilized as point of connection for photovoltaic system shall be suitable for backfed applications per 2008 NEC Article 690.64 (B) (5).
2. Connections to ground-fault protective devices shall be per 2008 NEC Article 690.64 (B) (3). Devices shall be suitable for backfed applications as required.

B. Ground equipment according to Division 26 Section *Grounding and Bonding.*

3.9 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Test for continuity of each circuit.
2. Test for output of inverters.
3. Test for short circuits.
4. Test all monitoring equipment, connections, and software to verify the monitoring system is fully integrated and operational.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:

1. Inspect inverters, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Report results in writing.

C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field test and inspections and prepare test reports:

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection per manufacturer's recommendations. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.10 PERMITS/INTERCONNECTION AGREEMENTS

A. Pay for and obtain all permits associated with this portion of the work.

B. Gather all information necessary for Utility Interconnection Agreement. Fill out and submit all paper work required to obtain Utility Interconnection Agreement.

C. Assist Owner with obtaining all available tax credits, rebates, and grants.

D. Assist Owner by providing information and filling out forms required to obtain Renewable Energy Credits.

3.11 DEMONSTRATION

A. Engage a factory-authorized service representative to provide a minimum eight (8) hours of training to the Owner's maintenance personnel to:

1. Adjust, operate, and maintain photovoltaic inverter(s).
2. Clean and maintain photovoltaic modules.
3. Operate and maintain data acquisition/monitoring system hardware and software.

END OF SECTION

DIVISION 26
SECTION 262416
PANELBOARDS
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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements" "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less.

B. Panelboards may be series fully rated for the AIC identified. Documentation must be provided to support series ratings with submittal package.

C. Related Sections include the following:

1. Division 26 Section "Common Work Results for Electrical" for general materials and installation methods.
2. Division 26 Section "Electrical Identification" for labeling materials.

1.3 SUBMITTALS

A. Product Data: For each type of panelboard, accessory item, and component specified.

B. Shop Drawings: For panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:

1. Enclosure type with details for types other than NEMA 250, Type 1.
2. Bus configuration and current ratings.
3. Short-circuit current rating of panelboard.
4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
5. Wiring Diagrams: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.

C. Qualification Data: For firms and persons specified in *Quality Assurance* Article.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

F. Maintenance Data: For panelboard components to include in the maintenance manuals specified in Division 01.

G. Project Record Data: Record actual locations of products, indicated actual branch circuit arrangement.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 01 Section *Quality Control* an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association.

1. Testing Agency's Field Supervisor: Person currently certified by the International Electrical Testing Association or National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled.

1. The Terms *Listed* and Labeled: As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* as defined in OSHA Regulation 1910.7.

C. Comply with NFPA 70.

D. Comply with NEMA AB1 *Molded Case Circuit Breakers*.

E. Comply with NEMA PB1, *Panelboards*.

F. Comply with NEMA PB1.1, *Instructions for Safe Installation, Operation & Maintenance of Panelboards Rated 600 Volts or Less.*

1.5 EXTRA MATERIALS

A. Keys: 2 spares of each type for panelboard cabinet lock.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, supply equipment from one of the following manufacturers; no other manufacturers are acceptable:

1. Square D Company. (Basis of Design)
2. Eaton Corp.; Cutler-Hammer Products.
3. Siemens Energy & Automation Inc.

2.2 PANELBOARD FABRICATION

A. Enclosures: Flush- or surface-mounted cabinets as indicated. NEMA PB1, Type 1, unless otherwise indicated to meet environmental conditions at installed location.

B. Front: Secured to box with concealed trim clamps, unless otherwise indicated. Front for surface-mounted panelboards shall be same dimensions as box. Fronts for flush panelboards shall overlap box, unless otherwise indicated.

C. Directory Frame: Clear plastic cardholder, mounted inside each panelboard door.

D. Bus: Hard drawn copper of 98 percent conductivity.

E. Main and Neutral Lugs: Provide mechanical lugs to accommodate the conductors shown on the Contract Drawings.

F. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors. Bonded to box.

G. Service Equipment Approval: Listed for use as service equipment for panelboards with main service disconnect.

H. Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances, for the over-current protective device ampere ratings indicated for future installation of devices.

I. Special Features: Include the following features for panelboards as indicated:

1. Isolated Equipment Ground Bus: Adequate for branch-circuit equipment ground conductors; insulated from box.
2. Hinged Front Cover: Entire front trim hinged to box with standard door within hinged trim cover.
3. Provide 200 percent rated neutral bus for all computer and non-linear loads.
4. Gutter Barrier: Arranged to isolate section of gutter as indicated.
5. Subfeed: Over-current protective device or lug provision as indicated.
6. Feed-Through Lugs: Sized to accommodate feeders indicated.

2.3 POWER DISTRIBUTION PANELBOARDS

A. Interior

1. Basis of design is Square D I-LINE type. Continuous main current ratings as indicated on Contract Drawings not to exceed 1200 amperes maximum. Panelboard bus current ratings shall be determined by heat-rise tests in accordance with UL 67.
2. Provide UL listed short circuit current ratings (SCCR) as indicated on the contract drawings, not to exceed the lowest interrupting capacity rating of any circuit breaker installed with a maximum of 200,000 RMS symmetrical amperes. Main lug and main breaker panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230.VI and VII.
3. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus.
4. The bussing shall be fully rated with sequentially phased branch distribution. Bus bar plating shall run the entire length of the bus bar. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by fasteners.
5. Interior trim shall be of dead-front construction to shield user from all energized parts. Main circuit breakers through 800 amperes shall be vertically mounted. Main circuit breaker and main lug interiors shall be field convertible for top or bottom incoming feed.
6. A solidly bonded equipment ground bar shall be provided.
7. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted neutral will not be acceptable.

B. Group Mounted Circuit Breakers Through 1200A

1. Circuit breaker(s) shall be group mounted plug-on with mechanical restraint on a common pan or rail assembly.
2. Circuit breakers equipped with line terminal jaws shall not require additional external mounting hardware. Circuit breakers shall be held in mounted position by a self contained bracket secured to the mounting pan by fasteners. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.

3. All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.
4. Furnish thermal magnetic molded case circuit breakers for 250A frames and below.

C. Thermal Magnetic Molded Case Circuit Breakers

1. Molded case circuit breakers shall have integral thermal and instantaneous magnetic trip in each pole.
2. Circuit breakers shall have interrupting ratings as shown on the contract drawings, but not less than 18,000 AIC rms symmetrical amperes at rated voltage. Ampere ratings shall be as shown on the Drawings.

D. Enclosures

1. Type 1 Boxes

a). Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Zinc-coated galvanealed steel will not be acceptable.
b). Boxes shall have removable blank end walls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.

2. Type 1 Trim Fronts

a). Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI 49 medium gray enamel electrodeposited over cleaned phosphatized steel.
b). Trim front door shall have rounded corners and edges free of burrs.
c). Locks shall be cylindrical tumbler type with larger enclosures requiring sliding vault locks with 3-point latching. All lock assemblies shall be keyed alike.

2.4 LIGHTING AND APPLIANCE PANELBOARDS

A. Interior

1. Minimum short circuit current ratings as shown on the Contract Drawings, but not less than 10,000 AIC rms symmetrical amperes for 120/208V panelboards, and 18,000 AIC rms symmetrical amperes for 277/480V panelboards. Basis for design is Square D NQ (120/208V) and NF (277/480V).
2. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branchy circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat rise tests conducted in accordance with UL 67. Bus bar plating shall run the entire length of the bus bar. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and –G.
3. All current carrying parts shall be insulated from ground and phase to phase by high dielectric strength thermoplastic.

4. Interior trim shall be of dead front construction to shield user from energized parts. Dead front trim shall have preformed twist-outs covering unused mounting space.
5. Interiors shall be field convertible for top or bottom incoming feed. Main circuit breakers in 100A interiors shall be horizontally mounted. Main circuit breakers over 100A shall be vertically mounted. Sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

B. Main Circuit Breaker

1. Main circuit breakers shall have an over-center, trip free, toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be true rms sensing and be factory calibrated to operate in a 40 degrees C ambient environment. Thermal elements shall be ambient compensating above 40 degrees C.
2. Two and three pole circuit breakers shall have common tripping of all poles. Circuit breakers frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker that allows the user to simultaneously select the desired trip level of all poles. Circuit breakers shall have a push to trip button for maintenance and testing purposes.
3. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings.

C. Branch Circuit Breakers

1. Molded case branch circuit breakers shall have bolt-on type bus connectors.
2. Circuit breakers shall have an over-center toggle mechanism which will provide quick-make, quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers shall have common tripping of all poles.
3. There shall be two forms of visible trip indication. The breaker handle shall reside in a position between ON and OFF. In addition, there shall be a red VISI TRIP indicator appearing in the clear window of the circuit breaker housing.

D. Enclosures

1. Type 1 Boxes

   a). Boxes shall be galvanized steel constructed in accordance with UL 50 requirements. Galvannealed steel will not be acceptable.
   b). Boxes shall have removable end-walls with knockouts located on one end. Boxes shall have welded interior mounting studs.

2. Type 1 Fronts

a). Fronts shall meet strength and rigidity requirements per UL 50 standards. Front shall have ANSI 49 gray enamel electrodeposited over cleaned phosphatized steel.

b). Panelboards shall have MONO-FLAT fronts with concealed door hinges and mounted with trim screws. Front shall not be removable with the door locked. Doors on front shall have rounded corners and edges shall be free of burrs.

2.5 PANELBOARD SURGE PROTECTIVE DEVICES

A. Description: Integrated Surge Protective Devices (SPDs) in panelboards.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Square D Company - "IMA" Series (Basis of Design)
2. Eaton Corporation; Cutler-Hammer Products
3. Siemens Energy & Automation, Inc.

C. The manufacturer of the SPD shall be the same as the manufacturer of the electrical distribution equipment in which the SPDs are installed and shipped.

D. Standards - Most recent editions of:

1. Underwriters Laboratories:

a). UL 1449 - "Surge Protective Devices"
b). UL 1283 - "Electromagnetic Interference Filters"

2. ANSI/IEEE C62.41.1-2002, C62.41.2-2002, C62.45-2002
3. National Electrical Code: Article 285 - "Surge Protective Devices, 1 kV or Less"

E. Listing Requirements:

1. SPD shall bear the UL Mark and shall be Listed to most recent editions of UL 1449 and UL 1283. "Manufactured in accordance with" is not equivalent to UL Listing and does not meet the intent of this Specification.

F. SPD shall be UL labeled with 200kA Short Circuit Current Rating (SCCR). Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD, per 2008 NEC Article 285.6

G. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. Every suppression component of every mode, including Neutral-Ground (N-G), shall be protected by internal overcurrent and thermal overtemperature controls.

H. SPD shall be UL labeled with 20kA I-nominal (I-n) for compliance to UL 96A - "Installation Requirements for Lightning Protection Systems" for Master Label

Certificate, and NFPA 780 - "Standard for the Installation of Lightning Protection Systems."

I. Minimum surge current capability (single pulse rated) per phase shall be as follows:

1.	Service-Entrance Equipment:	320kA
2.	Distribution Panelboards:	240kA
3.	Branch Panelboards:	120kA

J. SPD shall provide surge current paths for all modes of protection: Line-Neutral (L-N), Line-Ground (L-G), and Neutral-Ground (N-G) for Wye systems; Line-Line (L-L), and Line-Ground (L-G) in Delta and impedance grounded Wye systems.

K. UL 1449 Listed Voltage Protection Ratings (VPRs) shall not exceed the following:

System Voltage	L-N	L-G	L-L	N-G	
208Y/120V		700V	700V	1200V	700V
480Y/277V		1200V	1200V	1800V	1200V

L. UL 1449 Listed Maximum Continuous Operating Voltage (MCOV):

System Voltage	MCOV	Allowable System Voltage Fluctuation (%)
208Y/120V	150V	25%
480Y/277V	320V	15%

M. SPD shall be constructed of one self-contained suppression module per phase.

N. Visible indication of proper SPD connection and operation shall be provided. SPD shall include LED indicator lights which shall indicate which phase as well as which module is fully operable.

O. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.

P. A push-to-test button shall be provided to test each phase indicator. Push-to-test button shall activate a state change of dry contacts for testing purposes.

Q. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.

R. A connector shall be provided along with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system. The output of the dry contacts shall indicate an end-of-life condition for the complete SPD or module.

S. Terminals shall be provided for necessary power and ground connections.

T. A transient voltage surge counter shall be located on the diagnostic panel on the front cover of the enclosure. The counter shall be equipped with a manual reset and battery backup to retain memory loss upon loss of AC power.

U. SPD shall have a warranty period of ten (10) years from date of invoice. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field service division.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards and accessory items according to NEMA PB 1.1.

B. Mounting: Plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

C. Install filler plates in unused spaces.

D. Provision for Future Circuits at Flush-Mounted Panelboards: Stub 1-inch (25 mm) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future and/or 1-inch (25 mm) empty conduits into raised floor space or below slab not on grade, in accordance with the following schedule:

Total Number of Single Pole Spares and Spaces	Number of 1-inch Empty Conduits
1 – 3	Two
4 – 6	Three
7 – 9	Four
10 – 12	Five
13 – 20	Ten
21 – 32	Fifteen

E. Wiring in Panelboard Gutters: Arrange conductors into groups, and bundle and wrap with wire ties after completing load balancing.

F. Two or three pole circuit breakers shall be common trip type. Single pole breakers with handle ties will not be permitted.

G. Tandem circuit breakers will not be permitted.

H. Multiple-section panelboards, as required by number of branch circuit breakers, shall consist of two or more cabinets with identical interiors mounted under separate trims. Cabinets, trims, and doors shall be the same size. Main lugs and busses of each section

shall be rated as indicated on the drawings. Where main breakers are indicated in multi-section panelboards the main breaker shall be contained in one section with feed-through lugs and sub-feed cables installed within panel, equal to the incoming feeder size. All buses and lugs shall have ampere capacity equal to or greater than the main breaker ampere rating. Loads shall be divided as evenly as practical between the sections in addition to being balanced over the phases.

I. Provide ground buses in panelboards as indicated on the Drawings. Ground bus shall be similar in all respects to neutral bus.

J. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289, *Application Guide for Ground Fault Circuit Interrupters.*

K. Branch circuit breakers (or switches) serving clocks, telephone and communications equipment, refrigerators, exit signs, fire alarm system controls, etc., shall be equipped with lock clips to prevent accidental operation.

L. Height: Six-feet, six-inches to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above the floor. Top breaker maximum height not to exceed 6 feet 8 inches.

3.2 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section “Electrical Identification”.

B. Panelboard Nameplates: Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

C. Panelboard Circuit Directories: Provide typewritten directories, indicating plainly what each branch circuit of the panelboard serves and where. Provide additional information as required by NEC. Spaces and spare breakers shall be written in pencil. Copying of Contract Drawing Panel Schedules and Descriptions shall not be acceptable. Circuit directories shall reflect final circuit connections, loads and locations after balancing of panelboard loads.

3.3 GROUNDING

A. Make equipment grounding connections for panelboards as indicated.

B. Provide ground continuity to main electrical ground bus as indicated.

3.4 CONNECTIONS

A. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.
2. Make continuity tests of each circuit.
3. Provide set of Contract Documents to test organization. Include full updating on final system configuration and parameters where they supplement or differ from those indicated in the original Contract Documents.

B. Testing Agency: Provide services of a qualified independent testing agency to perform specified testing.

C. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units, and retest.
3. Reports by Testing Organization: Report written reports of tests and observations. Report defective materials and workmanship and unsatisfactory test results. Include records of repairs and adjustments made.
4. Labeling: Upon satisfactory completion of tests and related effort, apply a label to tested components indicating results of tests and inspections, responsible organization and person, and date.
5. Protective Device Ratings and Settings: Verify indicated ratings and settings to be appropriate for final system configuration and parameters. Where discrepancies are found, recommend final protective device ratings and settings. Use accepted ratings or settings to make the final system adjustments.

D. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of all mechanical components and other operable devices in accordance with manufacturer’s instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer’s instructions for proper torque values.
5. Perform visual and mechanical inspection and related work for over-current protective devices.

E. Electrical Tests: Include the following items performed in accordance with manufacturer's instruction:

1. Insulation resistance test of buses and portions of control wiring that is disconnected from solid-state devices. Insulation resistance less than 100 megohms is not acceptable.
2. Ground resistance test on system and equipment ground connections.
3. Test main and subfeed over-current protective devices.

F. Retest: Correct deficiencies identified by tests and observations and provide retesting of panelboards by testing organization. Verify by the system tests that the total assembly meets specified requirements.

3.6 COMMISSIONING

A. Balancing Loads: After Substantial Completion, but not more than 2 months after Final Acceptance, conduct load-balancing measurements and make circuit changes as follows:

1. Perform measurements during period of normal working load as advised by Owner.
2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility. Make special arrangements with Owner to avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. Recheck loads after circuit changes 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 required to meet this minimum requirement.

3.7 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.8 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

END OF SECTION

DIVISION 26
SECTION 262713
METERING
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SECTION 262713 – METERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Division 26 Section "Common Work Results for Electrical".

C. Division 26 Section "Panelboards" for electricity meters installed within panelboard enclosures.

D. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SCOPE

A. Provide all equipment necessary to install electronic meters capable of measuring volts, power factor, kilowatts, kilowatt demand, amperes and thermal ampere demand for service entrance metering.

1.3 SUBMITTALS

A. Submit product data under provisions of Division 26 Section "Common Work Results for Electrical".

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

PART 2 - PRODUCTS

2.1 ELECTRONIC METER WITH DIGITAL DISPLAY

A. Three-phase electronic type suitable for connection to three (3) and four (4) wire circuits with the following features:

1. Meter shall be capable of measuring amperes (A), volts (V), power factor (PF), kilowatts (kW), kilowatt demand (kWd), kilovolt-amperes (KVA), kilovolt-amperes demand (kVAd), kilowatt-hours (kWh), kilovolt-ampere hours (kVAh), and Total Harmonic Distortion (THD).
2. Meter shall be equipped with a minimum of one (1) RS-485 Modbus communication port, one (1) digital input, one (1) KY-type digital output, and one (1) analog output.
3. Meter shall be equipped with high-visibility, anti-glare, backlit LCD display offering multi-phase measurements, summary services, bar charts, intuitive navigation and selectable languages.
4. Measurements shall meet the accuracy requirements of IEC 62053-22 Class 0.5S and ANSI C12.20 Class 0.5S.
5. Meter shall be equipped with non-volatile on-board memory for capable of extensive logging of min/max values, energy and demand, maintenance data, alarms and any measured parameters.
6. Meter shall provide custom alarming with time stamping.
7. Meter shall be equipped with two MOD-BUS serial ports and one ethernet port; ethernet port shall be interfaced with building's data network to provide e-mail on alarm to the Owner.
8. Current transformers shall be Square D Type 100R or approved equal.
9. Potential transformers shall be provided where 277/480V metering is required, unless electronic meter is DIN rail compatible and is mounted directly to the switchboard bussing.

B. Electronic meters shall be Square D Company, PowerLogic PM 820 Series, or approved equal by acceptable manufacturer.

2.2 METERING TRANSFORMERS

A. Manufacturer: Shall be Square D Company.

B. Current Transformers: ANSI C57.13.5 ampere secondary.

C. Voltage Transformers: ANSI C57.13;120 V single secondary, (Not required for type PM meters).

2.3 METERING TEST SWITCH

A. Provide ten position test switch with cover (4 potential and 6 current) ABB Type FT-1, or approved equal with each new metering installation.

2.4 CURRENT TRANSFORMERS

A. Five ampere secondary, wound, bushing, bar or window type as appropriate, with dual or multiple windings as shown on the Plans. Primary/secondary ratio as shown on the Plans, or as recommended by Coordination Study and Equipment Manufacturer. Burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

1. Ratio for dual rated CT's shall match rating of service and 1/2 rating of service (i.e., 1200/600:5 for a 1200 Amp service).
2. Dual-rated shorting terminal strip on CT wiring in metering compartment.
3. Provide shorting auxiliary contacts in test switch.

B. Dry, indoor, 600V type with accuracies in accordance with ANSI Standard C37.20 Section 20 -4.63.

C. Current transformer ratios as shown on drawings.

D. Mount and brace transformers to withstand 100,000 amp short circuit current.

E. Current transformers shall be Square D Type 100R or approved equal.

2.5 POTENTIAL TRANSFORMERS

A. One hundred twenty (120) volt single secondary with fused primary and secondary, primary/secondary ratio as shown on Drawings or as recommended by Coordination Study and Equipment Manufacturer, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.

1. Ratio: Shall be 2.4:1 for 3 Phase, 4 Wire wye configuration.

B. Dry, indoor, 600V type with accuracy's in accordance with ANSI standards. 10 kV (BIL).

C. Primary volts: 277 volts for 480 volt systems. Secondary volts: 120.

D. Potential transformers shall be provided where 277/480V metering is required.

E. Potential transformers shall be Square D or approved equal.

2.6 GROUND FAULT RELAY AND SENSOR:

A. Zero sequence sensor with adjustable ground fault relay. Adjustment from 100 o 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide with monitor panel and lamp to indicate relay operation, "TEST" and "RESET" control switches.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The meters shall be mounted in the locations indicated on the drawings. All unused openings shall be covered with a plate of similar material and painted to match the existing enclosure. Any extension of wiring needed to accommodate the meters shall be done using terminal blocks and #10 AWG stranded copper wire. The wire used for the extensions shall be 600V, Type SIS insulation. Splices are not allowed.

B. Since dangerous voltage shall develop in the open circuit secondary windings of energized current transformers, de-energize the current transformers by short circuiting the secondary windings before disconnecting or connecting instruments to current transformers.

C. Meters shall generally be mounted in new enclosure; however, exact locations shall be coordinated with the Engineer. See Drawings. Mounting height shall be 5'-5-inches or less from floor level.

D. Provide current transformer, ratio, and polarity tests.

E. Coordinate interlock requirements of demand meter with Automatic Temperature Controls System.

END OF SECTION

DIVISION 26
SECTION 262726
WIRING DEVICES
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SECTION 262726 - 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Straight-blade receptacles and associated device plates.
2. GFCI receptacles.
3. Locking receptacles.
4. Isolated-Ground receptacles.
5. Tamper-Resistant receptacles.
6. Weather-Resistant receptacles.
7. Toggle switches.
8. Wall-box dimmer switches.
9. Pendant cord-connector devices.
10. Cord and plug sets.
11. Emergency Pushbuttons

1.3 DEFINITIONS

A. EMI: Electromagnetic Interference.

B. GFCI: Ground-Fault Circuit Interrupter.

C. IG: Isolated-Ground.

D. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

E. RFI: Radio-Frequency Interference.

F. UTP: Unshielded Twisted Pair.

G. TR: Tamper-Resistant.

H. WR: Weather-Resistant.

1.4 SUBMITTALS

A. Product Data: For each product specified, indicating configurations, finishes, dimensions, and manufacturer's instructions.

B. Shop Drawings: Lists of legends and description of materials and press used for premarking wall plates.

C. Samples: As requested for devices and device plates for color selection and evaluation of technical features.

D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 01.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NFPA 70.

D. Comply with NECA Standard of Installation.

E. Codes: Provide wiring devices conforming to the following:

1. American National Standards Institute (ANSI): Provide lugs and receptacle devices constructed in accordance with ANSI C73, Attachment Plugs and Receptacles, Dimensions of.

2. Institute of Electrical and Electronics Engineers (IEEE): Construct and install wiring devices in accordance with requirements of IEEE 241, *Recommended Practice for Electric Power Systems in Commercial Building.*
3. National Electrical Manufacturers Association (NEMA): Provide wiring devices constructed and configured in accordance with the requirements of

    a. WD1: General Requirements for Wiring Devices
    b. WD2: Semiconductor Dimmers for Incandescent Lamps
    c. WD5: Special Purpose Wiring Devices
    d. WD6: Wiring Devices - Dimensional Requirements.

4. National Fire protection Association (NFPA): Comply with NFPA 70, *National Electrical Code* as applicable to construction and installation of electrical wiring devices.
5. Underwriters Laboratories, Inc. (UL): Provide wiring devices which are UL listed and comply with the requirements of:

    a. 5: Surface Metal Raceways and Fittings.
    b. 20: General-Use Snap Switches.
    c. 498: Attachments, Plugs and Receptacles
    d. 514A: Metallic Outlet Boxes.
    e. 514B: Fittings for Conduit and Outlet Boxes.
    f. 514C: Non-Metallic Outlet Boxes, Flush-Device Boxes, and Covers
    g. 943: Ground-Fault Circuit Interrupters

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.

1. Floor Service-Outlet Assemblies: One for each 10, but not less than one.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Wiring Devices:

    a. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
    b. Hubbell, Inc.; Wiring Device – Kellems (Hubbell)
    c. Leviton Manufacturing Co., Inc. (Leviton)
    d. Pass & Seymour/Legrand; Wiring Devices Div. (Pass & Seymour)

2. Multioutlet Assemblies:

    a. Airey-Thompson Co.
    b. American Electric
    c. Hubbell Inc. Wiring Devices
    d. Wiremold.

3. Floor Service Outlets:

    a. American Electric.
    b. Hubbell, Inc.; Wiring Devices Div.
    c. Pass & Seymour/Legrand; Wiring Devices Div.
    d. Square D Company.
    e. Wiremold.

2.2 STRAIGHT BLADE RECEPTACLES

A. Duplex Convenience Receptacles

1. Duplex convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
2. Hubbell HBL5362, or approved equal by acceptable manufacturer.

B. Single Convenience Receptacles

1. Single convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD1, NEMA WD6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
2. Hubbell HBL5361, or approved equal by acceptable manufacturer.

C. Special Purpose Receptacles

1. Special purpose receptacles shall have ratings and NEMA configurations as indicated on the Drawings, or as required to match equipment plug configuration, and shall be black with device plate to match outlet type.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, Federal Specification W-C-596, and UL 943, Class A, Group 1. Include solid

state ground-fault sensing and signaling, with a trip time of 0.025 seconds (nominal) and a trip threshold of +/- 5mA. Include indicator light that is lighted when device is tripped.

B. Duplex GFCI Receptacles

1. Duplex GFCI receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
2. Hubbell GF20LA, or approved equal by acceptable manufacturer.

C. Weather-Resistant Duplex GFCI Receptacles

1. Weather-resistant duplex GFCI receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, UL 498 and Federal Specification W-C-596.
2. Hubbell GFR5362SG, or approved equal by acceptable manufacturer.

2.4 LOCKING RECEPTACLES

A. Single Convenience Receptacles

1. Single convenience receptacles shall be extra heavy-duty, specification grade, 20A, 125V: Comply with NEMA WD1, NEMA WD6 configuration L5-20R, UL 498 and Federal Specification W-C-596.

B. Special Purpose Receptacles

1. Special purpose receptacles shall have ratings and NEMA configurations as indicated on the Drawings, or as required to match equipment plug configuration, and shall be black with device plate to match outlet type.

2.5 CORD AND PLUG SETS

A. Description: Match voltage and current ratings and number of conductors to requirements of equipment being connected.

1. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and equipment-rating ampacity plus a minimum of 30 percent.
2. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.6 SWITCHES

A. Toggle Switches

1. Toggle switches shall be quiet-type, extra heavy-duty, industrial grade, 120/277V, 20A: Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.
2. Hubbell HBL1221 (single-pole), HBL1222 (two-pole), HBL1223 (three-way), HBL1224 (four-way), or approved equal by acceptable manufacturer.

B. Pilot Light Switches

1. Pilot light switches shall be quiet-type, extra heavy-duty, industrial grade, with clear or red illuminated toggle (light on with load on), 120/277V, 20A: Comply with NEMA WD 1, UL 20 and Federal Specification W-S-896.
2. Hubbell HBL1221PL (single-pole), HBL1222PL (two-pole), HBL1223PL (three-way), or approved equal by acceptable manufacturer.

C. Dimmer Switches shall be Architectural specification grade, forward phase dimming, square law dimming, magnetic low voltage, solid-state units with integral, quiet on/off switches. RFI filtering to reduce radio, audio, and video equipment interference. Dimmer switches shall be sized by the Contractor to serve the load indicated on the Contract Drawings.

1. Control: Continuously smooth-action rotary dial. Single pole or three way switch to suit connections.
2. Incandescent Lamp Dimmers: Modular, 120 V, 60 Hz with continuously adjustable rotary knob, toggle, or slide; single pole with soft tap or other quiet switch; electromagnetic filter to eliminate noise, RF, and TV interference; and 5-inch (130mm) wire connecting leads.

2.7 FAN SPEED CONTROLS

A. Furnished by Division 23

2.8 DEVICE PLATES

A. Device plates shall be provided for all switches and receptacles. Device plates shall be as manufactured to fit each type of single device, to fit devices which are ganged together, and they shall be by Pass & Seymour, or approved equal, as follows:

1. Material for Finished Spaces: 0.04-inch-thick, Type 302, satin-finished stainless steel, except as otherwise indicated**.**
2. Material for unfinished Spaces: Galvanized steel.
3. Plate-Securing Screws: Metal with heads colored to match plate finish.

B. Material for Damp Locations: Heavy-duty die-cast zinc/aluminum construction listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be equipped with one or more lift cover(s) equipped with stainless steel springs. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch. Covers shall comply with NEC Section 406.9(A).

1. Duplex Receptacle, 2 Self-Closing Lids – Pass & Seymour Model No. CA8GH or approved equal
2. GFCI Receptacle, 1 Self-Closing Lid – Pass & Seymour Model No. CA26GH (Horizontal) and Pass & Seymour Model No. CA26GV (Vertical), or approved equal.
3. Toggle Switch – Pass & Seymour Model No. CA1GL or approved equal.
4. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.

C. Material for Wet Locations: Heavy-duty die-cast zinc/aluminum construction with gasketed, hinged lockable lid, designed to be weatherproof while the device is in use, and listed and labeled for use in "wet locations." All components shall have baked-on electrostatic, polyester, power paint finish for superior corrosion resistance. Covers for receptacles shall be self-closing per UL514C42.3, be equipped with stainless steel springs, and shall have a cam action latch for secure closure. Covers for toggle switches shall be equipped with actuating levers and shall mount directly over the switch. Covers shall comply with NEC Section 406.9(B) for Outdoor Wet Location covers and NEMA Standard 3R.

1. Duplex/GFCI Receptacle - Pass & Seymour Model No. WIUCAST1 or approved equal.
2. Toggle switch – Pass & Seymour Model No. CAIGL, or approved equal.
3. Toggle switch, lockable cover – Crouse-Hinds Model No. DS185, or approved equal.

D. Provide jumbo size plates for outlets installed in masonry walls.

E. Provide typed permanent labels on all receptacle coverplates indicating panelboard name and circuit number for each receptacle.

2.9 PROTECTIVE WIRE GUARDS

A. Provide protective wireguards over devices subject to physical damage. All devices installed in the multi-purpose room or on the exterior of the building shall be provided with protective guards. Protective guards shall be manufacturer's recommended product for the device being protected or a suitable guard as manufactured by American Time & Signal Company (800-328-8996), Safety Technology International (STI) (800-888-4784), or Institutional Systems Services Corporation (800-524-0537).

B. Devices to be provided with protective guards include, but are not limited to, the following:

1. Clocks
2. Bell/Smoke/Heat Detectors
3. Fire Alarm Pull Stations
4. Thermostats
5. Speaker Horn
6. Fire Alarm Strobe, Horn, Speaker
7. Exit Signs
8. Emergency Lights
9. Telephones

10. Data Outlets
11. Security Devices/Motion Detectors
12. Wiring Devices
13. Emergency Shut-Off Stations
14. Other Devices as required by Owner
15. Gymnasium Lighting Fixtures

C. Guard shall be fabricated from ¼-inch (9-gauge) cold-rolled steel rods, welded together with mounting tabs. Guard shall be finished with a powder-based epoxy to protect against corrosion. Finish color shall match the finishes for the area being installed, except guards for fire alarm devices shall be red finish color.

D. Protective Devices shall be considered incidental to the product installed in an area subject to damage as indicated on the drawings and shall be provided at no additional cost to the Owner.

2.10 FLOOR-MOUNTED DEVICES

A. Individual, floor-mounted power, microphone, telephone, data, CATV, etc., outlets per plans. For multiple floor devices, combine outlets or jacks in common divided box with single, multi-gang coverplate.

B. General:

1. Flush-mounted, rectangular boxes: 1, 2, or 3 gang.
2. Carpet trim ring for devices in carpeted areas. Provide carpet insert.
3. For tiles, wood, or other hard floors, provide flush trim and coverplates, with no projections above the floor surface.
4. Single or multi-gang coverplates as required.

C. Construction:

1. Cast iron boxes, 3-5/16-inches deep.
2. 1, 2, or 3 divided compartments.
3. Fully adjustable prior to concrete pour.
4. Walker Omnibox 880CS Series, or equal.

D. Activation Kits:

1. Textured polycarbonate adjusting trim and cover plates.
2. Microphone outlets on stage:

    a. Completely flush with no raised edges.
    b. Brass cover with duplex flip-lid type covers.
    c. Walker #828PR.

E. Receptacles, jacks and connectors: Provide receptacles, data, telephone, CATV and other connectors and wiring as specified elsewhere.

2.11 EMERGENCY PUSHBUTTONS

A. General:

1. Emergency pushbuttons shall be Stopper Station with Bopper Stopper cover, as manufactured by Safety Technology International, Inc. (STI), or approved equal.

B. Features:

1. Button activation shall be Push-to-Activate, Turn-to-Reset.
2. Interchangeable or replaceable Normally Open (N.O.) or Normally Closed (N.C.), Single-Pole, Single-Throw (SPST) gold-plated contact blocks rated for three (3) amps at 600 VAC or one (1) amp at 250VDC.
3. Standard switch shall include one N.O. and one N.C. contact.
4. Switch shall hold up to three (3) sets of isolated contacts.

C. Construction:

1. Housing shall be molded of polycarbonate rated for temperature range of -40 degrees to 250 degrees Fahrenheit.
2. Housing color shall be yellow, unless otherwise indicated.
3. Pushbutton shall be provided with stainless steel backplate and matching polycarbonate spacer (as required), both having a 5VA flammability rating.

D. Labeling:

1. Pushbuttons shall be provided with a vinyl label that is customized to suit each application, including, but not limited to the following:

    a. “Emergency Power Off”
    b. “Water Heater Shut-Down”

E. Cover

1. Pushbutton covers shall have the following features:

    a. Molded from thick clear polycarbonate material.
    b. UV stabilized.
    c. 94V-2 flammability rating.
    d. Stainless steel torsion spring to maintain cover in a closed position.
    e. Mounting hardware and gasket.

F. Quality Assurance

1. Pushbuttons shall be tested and approved or listed by:

    a. Underwriter Laboratories (UL) and Canadian Underwriter Laboratories No. S7255.
    b. Complies with UL 2017.

c. UL listed for indoor and outdoor use, when used with appropriate weather cover.

2. Pushbuttons shall be ADA Compliant.

G. Warranty

1. Pushbuttons shall be provided with lifetime guarantee against breakage of polycarbonate in normal use.
2. Pushbuttons shall be provided with one year guarantee on electro-mechanical and electronic components.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of existing conditions before starting work.

B. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

1. Verify that outlet boxes are installed at proper height.
2. Verify that wall openings are neatly cut and will be completely covered by wall plates.
3. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.

C. By beginning Work, accepts conditions and assume responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

3.2 INSTALLATION

A. Install devices and assemblies plumb, level, and secure.

B. Install wall plates when painting is complete.

C. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.

D. Do not share neutral conductor on load side of dimmers.

E. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical, and grounding terminal of receptacles on top. Exception: Mount exterior GFCI weatherproof duplex receptacles horizontally. Group adjacent switches under single, multi-gang wall plates.

F. Protect devices and assemblies during painting.

G. Adjust locations at which floor service outlets and telephone/power service poles are installed to suit arrangement of partitions and furnishings.

H. Coordinate cord and plug connected equipment for type and ratings required.

I. Emergency shut-down toggle switches for boilers shall be provided at all means of egress from rooms in which boilers are installed. Boiler shut-down switches shall be clearly identified and shall be equipped with illuminated red toggle.

J. Receptacles on emergency circuits shall be clearly identified, with a circuit label indicating panelboard and circuit number.

K. All exterior receptacles and receptacles installed in wet or damp locations shall be ground fault interrupter type and weatherproof.

L. All receptacles installed within six (6) feet of sinks, plumbing fixtures, and water pipes shall be ground fault circuit interrupter type.

M. Switches shall be located as indicated on the drawings, arranged singular or in gangs within 18" of the door jam on the strike side of the door openings. Verify the door swings with the Architectural Drawings prior to rough-in.

N. Install life safety system switches separate from the normal power switches. Do not include in the multiple gang configuration.

O. Switch and receptacle combinations shall be as above in a 2-gang box where both are of the same voltage. Provide separate boxes where different voltages are present.

P. Install receptacles with ground pole in position top or as required by local authority having jurisdiction.

3.3 IDENTIFICATION

A. Comply with Division 26 Section, *Electrical Identification*.

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate. Light switches shall be labeled as to lights controlled and with circuit number and panel identification.
2. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes. Protect label from damage during construction. Replace all damaged and unclear labels.
3. Mark all conductors with the panel and circuit number serving the device at the device.
4. Mark the panel and circuit number serving the device on the back side of the device plate with a permanent marking system, machine-generated, that does not show through the front of the plate.

3.4 CONNECTIONS

A. Connect wiring device grounding terminal to outlet box with bonding jumper.

B. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.

C. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 FIELD QUALITY CONTROL

A. Test wiring devices for proper polarity, continuity, short circuits, and ground continuity. Operate each device at least six times.

B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.

C. Replace damaged or defective components.

3.6 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION

DIVISION 26
SECTION 262813
FUSES
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SECTION 262813 - 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1. Fuses.
2. Spare Fuse Cabinet.

B. The electrical contractor shall provide a complete set of fuses for all fusible equipment on the project as indicated on the Contract Documents. Final test and inspections shall be made prior to energizing the equipment.

1.3 PERFORMANCE REQUIREMENTS

A. Select fuses to provide appropriate levels of short circuit and overcurrent protection for components such as wire, cable, bus structures, and other equipment. Provide system to ensure that component damage is within acceptable levels during a fault.

B. Select fuses to coordinate with time-current characteristics of other overcurrent protective elements, such as other fuses, circuit breakers, and protective relays. Provide system to ensure that device closest to fault operates.

1.4 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Section.

B. Product Data for each fuse type specified. Include the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for fuses with current-limiting characteristics

3. Coordination charts and tables and related data.
4. Fuse size for elevator feeder and disconnect applications.

C. Field test reports indicating and interpreting test results.

D. Maintenance data for tripping devices to include in the Operation and Maintenance Manual specified in Division 01.

E. Record the equipment nameplate rating and actual fuse rating and location of fuses on the record drawings.

F. Provide a complete short circuit coordination study report as required to select fuses to protect equipment.

G. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fuses from one source and by a single manufacturer.

B. Comply with NFPA 70 for components and installation.

C. Listing and Labeling: Provide fuses specified in this Section that are listed and labeled.

1. The terms *Listed* and *Labeled* as defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.
3. Comply with National Electrical Manufacturer's Association NEMA FU-1 *Low Voltage Cartridge Fuses.*
4. Comply with IEC269.
5. Comply with CANENA Standard 248.
6. Comply with UL 198.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Fuses: Furnish quantity equal to 20 percent of each 600 ampere and smaller fuse type and size installed, but not less than one (1) set of three (3) of each type and size. (Provide three (3) of each 601 Ampere and larger fuse type and size installed.)
2. Fuse Pullers: Furnish two (2) fuse pullers.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fuses that may be incorporated into the Work include, but are not limited to, the following:

1. Cooper Industries Inc. Bussmann Div.
2. Eagle Electric Mfg, Co. Inc.
3. Ferraz Corp
4. General Electric Co; Wiring Devices Div.
5. Gould Shawmut.
6. Tracor, Inc; Littelfuse, Inc. Subsidiary

B. All fuses shall be of the same manufacturer to assure coordination.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU-1, nonrenewable cartridge fuse; class as specified or indicated; current rating as indicated; voltage rating consistent with circuit voltage.

2.3 SPARE FUSE CABINET

A. Cabinet: Wall mounted, 0.05 inch (1.27) mm) thick steel unit with full length, recessed piano-hinged door with key coded cam lock and pull, and circuit voltage.

1. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
2. Size: Adequate for orderly storage of spare fuses specified with 15 percent spare capacity minimum.
3. Finish: Gray, baked enamel.
4. Identification: Provide equipment nameplate to read *SPARE FUSES* in 1-1/2-inch (40-mm) letters on door.
5. Fuse Pullers: For each size fuse.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine utilization equipment nameplates and installation instructions to verify proper fuse locations, sizes, and characteristics.

B. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 FUSE APPLICATIONS

A. Main Service: Class L, fast acting, 600 Volt, 601-6000 Amp, and 300 kA interrupting rating.

B. Main Feeders: Class J, time delay, 600Volt, 0-600 Amp, and 300 kA interrupting rating.

C. Motor Branch Circuits: Class RK1, time delay, 250 Volt Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating. Time delay fuses shall hold 500% of rated current for a minimum of 10 seconds.

D. Other Branch Circuits: Class RK1, non-time delay, 250 Volt, Class J Time Delay 600 Volt, 0-600 Amp, and 300 kA interrupting rating.

E. Provide fuses of type and rating recommended by equipment manufacturer for packaged and/or specialized equipment.

F. Motor, transformer, feeder, and main service protection - 250 Volts or less:

1. Six hundred (600) ampere and less in interrupter switches, Class RK1, dual elements, time delay, 300 kA interrupting rating.
2. Four hundred (400) to six hundred (600) ampere in bolted pressure switches, Class J, 300 kA interrupting rating.

G. Motor, transformer, feeder, and main service protection - 600 volts or less; 600 ampere and less - Class RK-1, dual element, time delay, 300 kA interrupting rating.

H. Six hundred (600) ampere to six thousand (6000) ampere fuses used for protection of services, mains and feeders, Class L, current-limiting, time delay, 300 kA interrupting rating, rms symmetrical. Fuses shall be time delay and shall hold 500 percent of rated current for a minimum of four (4) seconds, clear 20 times rated current in 0.01 second or less, UL listed.

I. Six hundred ampere or less, installed ahead of breaker: Class RK1, time delay.

J. Six hundred ampere or less, for general power circuits: Class J, time-delay, dual element, 300 kA interrupting rating. Time-delay fuses shall hold 500 percent of rated current for a minimum of 10 seconds and shall be UL listed.

K. Fuse sizes for motor protection shall be chosen from fuse manufacturers published data and recommendations.

L. Control circuits and lighting: Class CC, current limiting rejection type, rated 0-30 amperes, 600 volts, and 200- kA interrupting rating.

M. Motor Circuits: All individual motor circuits with full-load ampere ratings (FLA) of 480 amperes or less shall be protected by Dual-Element Time-Delay Fuses. The following guidelines apply for motors protected by properly sized overload relays: Fuses for motors with a marked service factor not less than 1.15 shall be installed in ratings of 125% of motor full-load current (or next size larger if 125 percent does not correspond to a fuse size), except where high ambient temperatures prevail, or where the motor drives a heavy revolving part which cannot be brought up to full speed quickly, such as large fans. Under such conditions, the fuses may be 150 percent to 175 percent of the motor full-load current. For all other motors, (such as 1.0 service factor motors) fuses shall be sized in ratings of 115 percent of the motor full load current (or next size larger if 115 percent does not correspond to a fuse size) except as noted above. The following guidelines apply where fuses are used as the only overload protection for the motor:

1. For motors with a 1.15 service factor or more, fuses should be sized at 125 percent of motor full-load current (or next size smaller if 125 percent does not correspond to a fuse size).
2. For all other motors, fuses should be sized at 115 percent of motor full-load current (or next size smaller, if 115 percent does not correspond to a fuse size.

N. Motor Controllers: NEMA and IEC Style motor controllers shall be protected from short-circuits by Dual-Element Time-Delay fuses in order to provide testing agency-witnessed Type 2 coordination for the controller. This provides *no damage* protection for the controller, under low and high level fault conditions, as required by IEC Publication 947-4. For IEC style controller, the fuses shall be installed in ratings to coordinate with the overload relays, such that the relay/fuse curves cross over at 7-10 times the IEC contactor current rating.

O. Switchboards and Panelboards: The manufacturer shall supply equipment utilizing fully-rated and listed components. This equipment shall be tested, listed, and labeled for the available short-circuit current.

3.3 INSTALLATION

A. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed. Final tests and inspections shall be made prior to energizing the equipment. This shall include a thorough cleaning, tightening, and review of all electrical connections and inspection of all grounding conductors. All fuses shall be furnished and installed by the electrical contractor. All fuses shall be of the same manufacturer.

B. Install fuses in fusible devices as indicated. Arrange fuses so fuse ratings are readable without removing fuse.

C. Install spare fuse cabinet where indicated.

D. Provide fuse clips as required.

3.4 IDENTIFICATION

A. Install typewritten labels on inside door of each fused switch to indicate fuse replacement information.

END OF SECTION

DIVISION 26
SECTION 262816
DISCONNECT SWITCHES AND CIRCUIT BREAKERS
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SECTION 262816 - DISCONNECT 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 Division 01 Specification Sections, apply to this Section.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes individually mounted switches and circuit breakers used for the following:

1. Service disconnect switches.
2. Feeder and equipment disconnect switches.
3. Feeder branch-circuit protection.
4. Motor disconnect switches.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 26 Section, *Wiring Devices* for attachment plugs and receptacles, and snap switches used for disconnect switches.
2. Division 26 Section, *Fuses* for fuses in fusible disconnect switches.

C. Provide method of disconnection at all appliances, motors, equipment, etc., as required to comply with NEC (including Article 422-C, and Article 440-D).

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division 01 Specification Sections.

B. Product Data for switches**,** circuit breakers, and accessories specified in this Section. Include the following:

1. Descriptive data and time-current curves.
2. Let-through current curves for circuit breakers with current-limiting characteristics.

C. Coordination charts and tables and related data.

D. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

F. Field test reports indicating and interpreting test results.

G. Maintenance data for tripping devices to include in the operation and maintenance manual specified in Division 01.

H. Submit a schedule of equipment to indicate ratings of disconnects, fuses, circuit breakers, and other electrical characteristics for each item of equipment.

I. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: In addition to the requirements specified in Division 01 Section, *Quality Control*, an independent testing agency shall meet OSHA criteria for accreditation of testing laboratories, Title 29, Part 1907, or shall be a full member company of the International Electrical Testing Association (NETA).

1. Testing Agency's Field Supervisor: Person currently certified by NETA or the National Institute for Certification in Engineering Technologies, to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain disconnect switches and circuit breakers from one source and by a single manufacturer.

C. Comply with NFPA 70 for components and installation.

D. Listing and Labeling: Provide disconnect switches and circuit breakers specified in this Section that are listed and labeled.

1. The Terms *Listed* and *Labeled*: As defined in the National Electrical Code, Article 100.

2. Listing and Labeling Agency Qualifications: A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.
3. Underwriters Laboratories (UL) listed equipment: UL 98 - Enclosed and Dead Front Switches, UL 50 - Cabinets and Boxes, UL489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures, NEMA 250 - Enclosures for Electrical Equipment.
4. Comply with ANSI and NEMA Standards for materials ratings.
5. Replacement circuit breakers shall be obtained from the original manufacturer through an authorized factory distribution complete with full factory warranty. Original manufacturer product data shall be submitted for review.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the Work include, but are not limited to, the following:

1. Fusible Switches:

   a. Square D Company. (Basis of Design)
   b. Eaton Corp.; Cutler-Hammer.
   c. Siemens Energy & Automation, Inc.

2. Molded-Case Circuit Breakers:

   a. Square D Company. (Basis of Design)
   b. Eaton Corporation; Cutler-Hammer.
   c. Siemens Energy & Automation, Inc.

3. Combination Circuit Breaker and Ground Fault Trip:

   a. Square D Company. (Basis of Design)
   b. Eaton Corporation, Cutler-Hammer.
   c. Siemens Energy & Automation, Inc.

4. Molded-Case, Current-Limiting Circuit Breakers:

   a. Square D Company. (Basis of Design)
   b. Eaton Corporation, Cutler-Hammer.
   c. Siemens Energy & Automation, Inc.

5. Integrally Fused, Molded-Case Circuit Breakers:

   a. Square D Company (Basis of Design)
   b. Eaton Corporation, Cutler-Hammer.
   c. Siemens Energy & Automation, Inc.

2.2 DISCONNECT SWITCHES

A. Enclosed, Nonfusible Switch: Heavy duty, NEMA KS 1, Type HD, with lockable handle in the *OFF* position. Switch shall be provided with an override screw to permit opening front cover with switch in *ON* position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.

B. Enclosed, Fusible Switch, 800 A and Smaller: Heavy duty, NEMA KS 1, Type HD, clips to accommodate specified fuses, enclosure consistent with environment where located, handle lockable in the *OFF* position, with 2 padlocks, and interlocked with cover in CLOSED position. Switch shall be provided with an override screw to permit opening front cover with switch in *ON* position. Minimum fault current rating shall be 200,000 symmetrical rms amperes.

C. Characteristics: Size, number of poles and ratings as indicated and to match load being served.

D. Enclosure: NEMA KS 1, Type 1, with gray baked enamel finish, unless otherwise specified or required to meet environmental conditions of installed location. Enclosure shall be rated for 200,000 rms symmetrical amperes short circuit current.

1. Outdoor Locations: Type 3R, with top-hinged, attached with removable screws.
2. Wet or Damp Indoor Locations: Type 4.

2.3 ENCLOSED CIRCUIT BREAKERS

A. Enclosed, Molded-Case Circuit Breaker: NEMA AB 1, with lockable handle.

B. Characteristics: Frame size, trip rating, number of poles, and auxiliary devices as indicated and interrupting rating to meet available fault current, minimum of 10,000 symmetrical rms amperes.

C. Application Listing: Appropriate for application, including switching fluorescent lighting loads or heating, air-conditioning, and refrigerating equipment.

D. Circuit Breakers, 200 A and Larger: Trip units interchangeable within frame size.

E. Circuit Breakers, 400 A and Larger: Field-adjustable, short-time and continuous-current settings.

F. Current-Limiting Trips: Where indicated, let-through ratings less than NEMA FU 1, Class RK-5.

G. Current Limiters: Where indicated, integral fuse listed for circuit breaker.

H. Molded-Case Switch: Where indicated, molded-case circuit breaker without trip units.

I. Lugs: Mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

J. Shunt Trip: Where indicated. Provide voltage rating as required.

K. Accessories: As indicated.

L. Enclosure: NEMA AB 1, Type 1, unless otherwise specified or required to meet environmental conditions of installed location.

1. Outdoor Locations: Type 3R.
2. Wet or Damp Indoor Locations: Type 4X, Stainless Steel.

M. Provide full capacity neutral lug or 200 full capacity neutral for non-linear loads and equipment grounding lug and isolated ground lug where isolated grounding is indicated.

N. Transient Voltage Surge Suppressors: IEEE C62.41, to meet requirements for category indicated.

1. Exposure: Low.
2. Exposure: Medium.
3. Exposure: High.
4. Impulse sparkover voltage coordinated with system circuit voltage.
5. Factory mounted with UL-recognized mounting device.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install disconnect switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches and circuit breakers level and plumb. Provide mounting brackets, wall bracing, and accessories as required.

C. Install wiring between disconnect switches**,** circuit breakers, control, and indication devices.

D. Connect disconnect switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Identify each disconnect switch and circuit breaker according to requirements specified in Division 26 Section, *Electrical Identification.* All switches shall be provided with laminated plastic labels which clearly identify the equipment served.

1. Each disconnect means shall be legibly marked as required by Code (including all disconnect units for motors, appliances, feeders, and branch(es).

F. Provide fuses for all fusible safety switches as indicated and required by the load being served. Coordinate fusing of disconnects with mechanical equipment electrical characteristics.

G. Provide disconnect switches for all equipment as indicated and as required by the NEC. Where disconnect switches are specified and furnished with mechanical equipment, install one only. Coordinate devices furnished for mechanical equipment with Division 23 Drawings and Specifications.

H. Weatherproof switches shall be provided for all locations exposed to the elements whether called for or not.

I. Switches and circuit breakers shall be labeled for service entrance use, if so required, where used for service entrance whether called for or not.

J. Switches and circuit breakers provided shall be suitable for:

1. Circuit application voltage.
2. Circuit application ampacity x 125 percent. One pole, two pole, three pole, solid neutral, ground connection, all as required by item served or as shown on the drawings.

K. Install disconnect switches and circuit breakers as indicated, complying with manufacturer's written instructions, applicable requirements of NEC, NEMA, and NECA's *Standard of Installation*, and in accordance with recognized industry practices.

3.2 FIELD QUALITY CONTROL

A. Testing: After installing disconnect switches and breakers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section 7.5 for disconnect switches and Section 7.6 for molded-case circuit breakers.
2. Certify compliance with test parameters.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

3.3 ADJUSTING

A. Set field-adjustable disconnect switches and circuit-breaker trip ranges as indicated.

3.4 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION

DIVISION 26
SECTION 264113
LIGHTNING PROTECTION SYSTEM
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SECTION 264113 - LIGHTNING 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.

B. Refer to Division 26, Section "Common Work Results for Electrical", for basic electrical installation requirements.

C. Refer to Division 26, Section "Panelboards", for requirements for Surge Protective Devices (SPD) installed in panelboards.

D. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements" "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 ALTERNATES

A. Refer to Division 01 Section "Alternates" for descriptions of Alternates that affect work in this Section.

1.3 SUMMARY

A. This section includes lightning protection systems for buildings and associated structures and includes requirements for lightning protection system components complying with UL96, UL96A, and NFPA 780.

B. Contractor shall provide additional components and labor in order to meet all requirements of Master Labeled Lightning Protection System.

1.4 SYSTEM DESCRIPTION

A. Protect entire building, including roof projections, chimneys, and roof-mounted equipment.

1. Building Construction: Concrete building less than 75 feet (23 m) in height.
2. Building Occupancy: Commercial.

B. Provide a complete UL Master Labeled Lightning Protection System.

C. Provide a complete all-inclusive Lightning Protection System Design layout and installation for a complete UL Master Labeled Lightning Protection System.

D. Design Requirements: Lightning Protection Conductor System consisting of air terminals on roofs, roof-mounted mechanical equipment, parapets, bonding of structure and other metal objects, grounding electrodes, and interconnecting conductors.

E. Provide an all-inclusive Lightning Protection System. The Contract Drawings and Specifications do not necessarily limit the extent of the system that is required to meet the requirements and the intent of the Engineer and the Contract Documents for a complete system.

1.5 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 01 Specification Sections.

B. Product data for each component: Include data for roof adhesive when used. Submit accurate pictorial views of decorative air terminal components. Provide dimensions and materials of each components and include indication of listing in accordance with UL 96.

C. Provide scaled shop drawings detailing lightning protection system including, but not limited to, air terminal locations, grounding electrodes, conductor sizes and routing, bonding connections to structures, and connections and grounding. Include connection and termination details. The shop drawings shall be Master Labeled stamped. Submit a roof plan and a ground floor plan with all equipment properly dimensioned.

D. Qualification data for firms and persons specified in *Quality Assurance* Article to demonstrate their capabilities and experience. Include list of completed projects with project names, addresses, names of Architects and Owners, and other information specified.

E. Field inspection reports indicating compliance with specified requirements.

F. Project Record Documents - Accurately record the following: Actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

G. Submit a UL compliance certificate indicating compliance with all requirements.

H. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced and LPI-Certified Master Installer to install the Lightning Protection System. The installation shall be under the direct supervision of an LPI-Certified Master Installer.

B. Designer Qualifications: Engage an LPI-Certified Designer to design and lay out the Lightning Protection System.

C. Inspector Qualifications: Engage an LPI-Certified Inspector to perform periodic inspections during installation of the Lightning Protection System.

D. Manufacturers Qualifications: Provide products by firms listed and approved by Underwriters Laboratories, Inc., having had not less than five (5) years experience in this specialty work under UL procedures.

E. Listing and Labeling: Provide products specified in this Section that are listed and labeled by an organization concerned with product evaluations, and that can determine compliance with appropriate standards for he current production of listed items.

1. Listing and Labeling Agency Qualifications; A *Nationally Recognized Testing Laboratory* (NRTL) as defined in OSHA Regulation 1910.7.

F. Conform to NFPA 780, *Lightning Protection Code*.

G. Conform to UL 96, *Standard for Lightning Protection Components*.

H. Conform to UL 96A, *Installation Requirements for Lightning Protection Systems* and provide UL Master Label.

I. Conform to LPI-175, *Lightning Protection Installation Standard* and provide LPI-certified system.

J. Conform to NFPA 70, *National Electrical Code*.

K. Conform to the most stringent requirements when more than one standard is specified for products or installation.

1.7 WORKMANSHIP

A. Guarantee all materials and workmanship furnished and installed under this section of the specifications two years from the date of final acceptance of work. The Contractor also agrees that he will, at his own expense, repair and/or replace all such defective materials or effective workmanship which become defective during the term of this guarantee.

1.8 SEQUENCING AND SCHEDULING

A. Coordinate installation of lightning protection system with the installation of other building systems and components, including electrical wiring, supporting structures and building

materials, metal bodies requiring bonding to lightning protection system, and building finishes.

1.9 LEED REQUIREMENTS

A. Refer to Division 01 Section LEED Requirements for description of work under this Division affected by LEED requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturer's offering lightning protection components that my be incorporated in the Work include, but are not limited to, the following:

1. A-C Lightning Security, Inc.
2. Bonded Lightning Protection, Inc.
3. East Coast Lightning Equipment, Inc.
4. Harger Lightning Protection, Inc.
5. Heary Brothers Lightning Protection.
6. Independent Protection Company, Inc.
7. Robbins Lightning Protection, Inc.
8. Thompson Lightning Protection.
9. Warren Lightning Rod Company.

2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Lightning Protection System Products: Manufactured to NFPA 780, LPI-176, *Lightning Protection System Material and Components Standard*, and UL 96, *Lightning Protection Components.*

B. System Materials: Copper with solid air terminals.

C. Air Terminals for Roof Mounting: Units with bases especially designed for the specified roof materials. Solid copper, 1/2-inch in diameter with blunt nickel-plated points.

1. Air Terminal Bases: Cast bronze with bolt pressure cable connections and shall be securely mounted with stainless steel screws and bolts. Bases on modified bitumen roofs shall be secured with a proper adhesive.
2. For portions of the building under 75 feet in height, Class I materials may be used. Air terminals shall be 1/2-inch diameter copper extending a minimum of 24 inches above the protected object. Wherever the air terminal and base come in direct contact with aluminum, aluminum materials must be used.

3. Wherever materials come in direct contact with aluminum surfaces on buildings over 75 feet in height, the air terminals shall be 5/8-inch diameter aluminum extending a minimum of 24 inches above the object they protect.
4. Wherever materials come into direct contact with aluminum surfaces on buildings under 75 feet in height, the air terminals shall be 1/2-inch diameter aluminum extending a minimum of 10 inches above the object they protect.

D. Ground Rods: Copper clad steel (10 mil finish) with a minimum of 7 percent of the rod weight in the copper cladding.

1. Diameter: 3/4 inch (19 mm).
2. Length: 10 feet (3 m).

E. Ground Plate: Solid copper, not less than 1/16th inch (2mm) thick.

F. Conductors:

1. Copper cable conductors: Class II - Twenty-eight strand copper.

a. Minimum 7/16-inch diameter.
b. Minimum 375 lbs. / 1000 LF.
c. Minimum #12 AWG conductors.
d. Minimum #1/0 AWG counterpoise.
e. For portions of the building under 75 feet in height, Class I materials may be used. The cable shall be 29 strands, 17 gauge per strand copper wire cable weighing 200 pounds per 1000 feet.

2. Aluminum cable conductors

a. Prohibited in contact with earth.
b. Prohibited where contributing to rapid corrosion.
c. Aluminum conductors for bonding or interconnecting metallic bodies to the main cable shall be #4 AWG aluminum wire in strength and cross section.
d. Perforated strips shall not be used.
e. In all areas where the cable comes in direct contact with aluminum material, aluminum cable must be used. For portions of the building over 75 feet in height, the aluminum cable should be 37 strands, 13 gauge per strand aluminum cable, weighing 190 pounds per 1000 feet. For portions of the building under 75 feet in height, the cable should be 24 strands, 14 gauge per strand aluminum cable, weighing 110 pounds per 1000 feet.

3. If the building has structural steel columns, the structural steel columns may be used as the down-conductors.

G. Connectors and Splices - Exothermic, conforming to UL 96.

H. Ground Test Well: For accessible connection for testing. Ground test well shall be heavy duty 12-inch length (minimum) with cast iron lid and frame.

I. Roof Penetrations: Through-roof assemblies with solid bars and appropriate roof flashings.

J. Miscellaneous Components: Provide other components required for a complete lightning protection system such as bonding plates, terminal supports, clips, anchors, fasteners, bolts, nuts, screws, etc. All components shall conform to UL 96 for applicable classes.

1. Bonding plates shall not be less than 8 square inches of surface contact secured in place with stainless steel bolts.

K. Conduit: Provide 1-inch Type 40 PVC conduit for all down conductors. All conduit shall be concealed.

L. Waterproof Penetrations: The Contractor shall provide all waterproofing for the through-roof conduits, connectors, and other penetrations.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive work.

B. Examine surfaces and conditions, with Installer present, for compliance with installation tolerances and other conditions affecting performance of the lightning protection system. Do not proceed with installation until unsatisfactory conditions have been corrected.

C. By beginning work, conditions are accepted with the responsibility for correcting unsuitable conditions encountered at no additional cost to the Owner.

D. Lightning Protection System shall be provided with UL Master Label Certificate. Turn UL Master Label Certificate over to Owner upon system approval, and include one (1) copy of the same in the Operation and Maintenance Manual(s).

3.2 INSTALLATION

A. Install lightning protection systems as indicated, according to manufacturer's written instructions.

B. Install components according to LPI-175, UL 96A, and NFPA 78.

C. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops. Run conductors in nonmetallic raceway, Schedule 40, minimum.

D. Conceal system conductors. Support conductors every three (3) feet.

E. Conceal down conductors.

F. Conceal interior conductors.

G. Conceal conductors from normal view from exterior locations at grade within 200 feet (60 m) of building.

H. Notify Engineer at least 48 hours before concealing lightning protection system components.

I. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components, except those above single-ply membrane roofing.

J. Air Terminals on Specified roofing: Use adhesive recommended by manufacturer of air terminals and approved by manufacturer of roofing material. Comply with adhesive manufacturer's installation instructions. Maximum spacing of 25 feet.

K. Bond extremities of vertical metal bodies exceeding 60 feet (18 m) in length to the Lightning Protection System.

L. Bond ground terminals with counterpoise conductor located below grade.

M. Bond grounded media on building within 12 feet (4 m) of ground with counterpoise conductor located as indicated.

N. Bond grounded media on building within 1 foot (4m) of roof with counterpoise conductor.

O. Bond grounded media on building within 12 feet (4m) of roof with interconnecting loop at eave level or above.

P. Bond lightning protection system to grounded media on building at every 60 feet (18 m) with intermediate-level interconnection loop conductors.

Q. Install the conductors as inconspicuously as practical and with the proper bends. Install conductors avoiding radius bends of less than 8 inches.

R. Install the vertical conductors within the concealed cavity of exterior walls. Route the conductors to the exterior at elevations below the finished grade and make the ground connections to the earth outside of the building or stack perimeter.

S. Where shown, use the structural steel framework or reinforcing steel as the main conductor: Weld or bond the non-electrically-continuous sections together and make them electrically-continuous.

T. Protect copper conductors with stiff copper or brass tubing, which enclose the conductors from the top to the bottom of the tubing, between 300 mm (one foot) below and 2100 mm (seven feet) above the finished grade.

U. Sheath copper conductors, which pass over cast stone. Cut stone, architectural concrete, and masonry surfaces with not less than a 2 mm (1/16-inch) thickness of lead to prevent staining of the exterior finish surfaces.

3.3 AIR TERMINAL INSTALLATION

A. Install per UL and NFPA requirements:

1. Rigidly connect to structure.
2. Make electrically continuous with roof conductors by means of pressure connectors or crimped joints.
3. At ends of structures, set 24-inches from end of ridge or edges and corner of roof.
4. Maximum spacing of 25 feet.
5. Prevent overturning by means of tripod or braces.
6. Uniformly space air terminals about the rim of the stack, not more than 24 inches from the corners or more than 8'-0-inches apart.
7. Air terminals on standing seam metal roof systems shall be secured with stainless steel clamps designed for standing seam metal roofing systems.

3.4 ROOF CONDUCTORS

A. Install per UL and NFPA requirements:

1. Connect directly to roof or ridge at 48-inch intervals.
2. Prevent sharp bends or turns.
3. Minimum bend radius of 8 inches.
4. Provide a downward or horizontal course.
5. All connections shall be electrically continuous.
6. Follow contours of flat roofs, ridges, parapets and edges.

3.5 DOWN CONDUCTORS

A. Installation:

1. Do not pass through non-conducting parts of structure.
2. Interconnect secondary conductors with grounded parts within the building.

B. Down Lead Conductors Run in Raceways: All down lead conductors shall be run in 1-inch Type 40 PVC conduit. All raceways shall be concealed. Raceways shall be placed at opposite sides of the stack. Bends shall be kept to a minimum and where used shall have an angle not to exceed 90 degrees. Openings shall be free and clear. Contractor shall provide conduits at various locations in the outer walls as required.

C. Provide a minimum of two down conductors located as widely separated as possible, at diagonally opposite corners.

D. Down lead cables shall not be brought directly through the roof. Through-roof assemblies with solid rods shall be used for this purpose.

3.6 INTERCONNECTION OF METAL PARTS

A. Metal doors, windows and gutters shall be connected directly to the grounds or down conductors using minimum No. 6 copper conductor, or equivalent. Increase size or protect conductors where exposed to corrosion or physical damage. Ground connections to metal doors and windows shall be by mechanical ties under pressure, or equivalent.

B. Metal ventilators shall be rigidly connected to the roof conductor at three places on the ventilator.

C. Metal bodies of conductance shall be protected if not within the zone of protection of the air terminals. All metal bodies having equal to, or greater than, 400 square inches shall be bonded to the lightning protection system using main size conductors and a bonding plate with not less than 3 square inches. Provisions shall be made to guard against corrosion due to joining of dissimilar metals. Provide air terminals on metals that are less than 3/16th-inch thick, which are not in the *cone of protection* on roof areas, such as ventilators, air conditioning units, etc., all as required by the stated Code.

D. All major rooftop mechanical equipment and isolated metal bodies within 6 feet of system conductors shall be bonded to lightning protections system's main roof conductor with secondary conductors and appropriate bonding devices. Do not penetrate airside housings for anchoring. Seal air and water tight all connections at mechanical equipment.

E. Interconnect conductive and inductive metals as required by the UL 96A Code.

F. Metallic portions of the solar photovoltaic (PV) and solar thermal system (s), including but not limited to modules, collectors, and mounting system shall be bonded to the Lightning Protection System using appropriately sized conductors and bonding plates.

3.7 GROUND CONNECTIONS

A. Use exothermic welding type connections which form solid metal joints in the main vertical and horizontal conductors, and for connections that are not exposed in the finish work.

B. Provide ground connection for each down conductor.

C. Metal water pipes and other large underground metallic objects shall be bonded together with all grounding mediums.

D. Ground connections shall be protected from mechanical injury.

E. In making ground connections, utilize permanently moist areas as applicable.

F. For the conductors located outside of the building, install the conductors not less than 2 feet (600 mm) below the finished grade.

G. Make connections of dissimilar metal with bi-metallic type fittings to prevent electrolytic action.

H. For structural steel buildings, connect the steel framework of the buildings to the main water pipe near the water system entrance to the building.

I. Connect exterior metal surfaces, located within 900 mm (three feet) of the lightning protection system conductors, to the lightning protection system conductors to prevent flashovers.

J. Do not pierce the structural steel in any manner. Connections to the structural steel shall conform to the UL Publication No. 96A.

K. Install ground connections to earth at not more than 1800 mm (60 foot) intervals around the perimeter of the building.

L. Weld or braze bonding plates, not less than 200 mm (eight inches) square, to cleaned sections of the steel and connect the conductors to the plates.

M. Connections to Lightning Protection System: Bond grounding conductors, including grounding-conductor conduits, to lightning protection down conductors or lightning protection grounding conductors in compliance with NFPA 750.

N. Common Ground Bonding with Lightning Protection System: Bond electric power system ground directly to lightning protection system grounding conductor at closest point to electric service grounding electrode. Use bonding conductor sized same as system grounding conductor and install in conduit.

3.8 GROUNDING ELECTRODES

A. Provide for each down conductor.

B. Drive into earth minimum of 10 feet. Ground rods shall be not less than 2 feet, nor more than 10 feet from the structure.

C. Counterpoise shall be No. 1/0 copper cable and shall be laid around the perimeter of the structure in a trench.

D. Ground rods shall be installed such that the top is not less than 2 feet below finished grade.

E. Ground rod resistance shall not exceed 10 ohms. The resistance of the entire grounding system shall not exceed 5 ohms.

F. Provide test wells installed flush with the finished grade.

3.9 CORROSION PROTECTION

A. Use no combination of materials to form an electrolytic couple that will accelerate corrosion in the presence of moisture, unless moisture is permanently excluded from the junction of such materials.

B. Use conductors with suitable protective coatings where conditions would cause deterioration or corrosion of conductors.

3.10 FIELD QUALITY CONTROL

A. Periodic Inspection: Provide the services of a qualified inspector to perform periodic inspection according to LPI-177, *Inspection Guide for LPI Certified Systems*.

B. UL Inspection: Provide the services of Underwriters Laboratories, Inc. to perform inspections. Make revisions as required to obtain Master Label Certificate.

C. Certification: Two weeks prior to final inspection, deliver to the Owner four copies of the Certification that the installed lightning protection system has been inspected by a UL representative and has been approved by UL without variation.

D. Prior to commencement of any work, the Contractor shall obtain and deliver to the Owner the application and inspection forms necessary to file application for the LPI Certified System Certificates. As applicable, these forms include: Stage 1 - Grounding Inspection Report; Stage 2 - Concealed Components Inspection Report; and Stage 3 - Final Inspection Report.

E. The Contractor shall perform required inspections at the appropriate times and upon completion of the job shall forward the above Inspection Report forms to the Lightning Protection Institute to obtain the LPI Certified System Certificate.

F. Verify the electrical continuity by measuring the ground resistance to earth at the ground level, at the top of the building or stack, and at intermediate points with a sensitive ohmmeter. Compare the resistance readings. Ground resistance shall not exceed 5 ohms. Submit test results.

3.11 CONNECTIONS TO EXISTING SYSTEM

A. Where the drawings show the new lightning protection system connected to an existing lightning protection system without a UL master label, the new portion of the lightning system still requires inspection and labels as specified above for new work.

END OF SECTION

DIVISION 26
SECTION 265100
LIGHTING
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SECTION 265100 - 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.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes interior lighting fixtures, lamps, ballasts, emergency lighting units, and accessories.

B. Related Sections include the following: Division 26 Section "Programmable Lighting Control Panel" for programmable lighting control system.

C. Provide a lighting fixture for each fixture shown on the Drawings as described in this Specification, of the design and quality indicated herein. Provide fixtures complete, including lamps of the wattage and type indicated.

D. All materials, accessories, and any other equipment necessary for the complete and proper installation of all lighting fixtures included in this contract shall be furnished by the Contractor.

E. Conformance: Fixtures shall be manufactured in strict accordance with the Contract Drawings and Specifications.

F. Specifications and scale Drawings are intended to convey the salient features, function and character of the fixtures only, and do not undertake to illustrate or set forth every item or detail necessary for the work.

G. Minor details, not usually indicated on the Drawings nor specified, but that are necessary for the proper execution and completion of the fixtures, shall be included, the same as if they were herein specified or indicated on the Drawings.

H. Omissions: The Owner shall not be held responsible for the omission or absence of any detail, construction feature, etc., which may be required in the production of the fixtures. The responsibility of accurately fabricating the fixtures to the fulfillment of this Specification rests with the Contractor.

1.3 SUBMITTALS

A. Product Data: Submit fixture shop drawings in booklet form with separate sheet for each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:

1. Dimensions of fixtures.
2. Certified results of independent laboratory test for fixtures and lamps for electrical ratings and photometric data. Test data shall include manufacturer and model number for fixture being submitted.
3. Emergency lighting unit battery and charger.
4. Fluorescent and high-intensity-discharge ballasts.
5. Types of lamps.

B. Shop Drawings: Show details of nonstandard or custom fixtures. Indicate dimensions, weights, method of field assembly, components, features, and accessories.

1. Wiring Diagrams: Detail wiring for fixtures and differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Reflected ceiling plans and sections drawn to scale and coordinating fixture installation with ceiling grid, ceiling-mounted items and other components in the vicinity. Include work of all trades that is to be installed near lighting equipment.

D. Samples for Verification: For lighting fixtures designated for sample submission in this Specification.

1. Lamps: Specified units installed.
2. Ballast: 120-V model of specified ballast type.
3. Accessories: Cord and plug.

E. Product Certificates: Signed by manufacturers of lighting fixtures certifying that products comply with requirements.

F. Dimming Ballast Compatibility Certificates: Signed by manufacturer of ballast certifying that ballasts are compatible with dimming systems and equipment with which they are used.

G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

H. Record Documents: Accurately record actual location of each luminaire with the associated switching/control arrangement.

I. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 01. Include technical data sheets and parts ordering information. Include testing and maintenance requirements and instructions for emergency lighting equipment.

J. Lighting Calculations: Submit point-by-point lighting calculations for fixture types noted in this Specification. All calculations shall strictly conform to IES Standards.

K. Samples: Provide samples for verification purposes of specific individual fixtures as noted in this Specification. Refer to paragraph "Samples", in this Section, for additional information.

L. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.4 SAMPLES

A. After shop drawing review and prior to release for manufacturing, the Contractor shall furnish one sample of each fixture in this Specification for which sample requirement is noted.

B. Shipping: The samples shall be complete with specified lamps and compatible ballast, ready for hanging, energizing, and examining, and shall be shipped, prepaid by the Contractor, to the Engineer, or as otherwise advised.

C. Two weeks from the date received shall be allowed for thorough examination of the samples by the Engineer.

D. Return: Samples are returnable, the Contractor shall arrange for return, prepaid shipping and pickup of each sample submitted.

E. Samples must be actual working units of materials to be supplied.

F. Samples shall be submitted by the Contractor for each substituted lighting fixture as requested for review by the Owner and Engineer.

1.5 QUALITY ASSURANCE

A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction. Provide only UL listed and labeled fixtures with UL listed wiring. Wiring shall be suitable for the fixture temperature listing.

B. Comply with NFPA 70.

C. FM Compliance: Fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM.

D. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

E. Mockups: Provide lighting fixtures for room or module mockups where required by the Architect. Install fixtures for mockups with power and control connections.

1. Obtain Architect's approval of fixtures for mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
3. Remove mockups when directed. Fixtures may be reinstalled in the Work with approval of Architect.
4. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. UL Listing: All fixtures shall be manufactured in strict accordance with the appropriate and current requirements of the Underwriters' Laboratories, Inc. (Standards for Safety), and others as they may be applicable. A UL listing shall be provided for each fixture type and the appropriate label or labels shall be affixed to each fixture in a position concealing it from normal view.

G. Installer: All Installers shall have not less than five (5) years' experience in the installation of lighting fixtures of the type and quality shown.

H. Materials, equipment and appurtenances, as well as workmanship provided under this Section, shall conform to the highest commercial standard as specified and as indicated on the drawings.

I. Electrical Code Compliance: Comply with applicable local code requirements of the authority having jurisdiction and NEC Articles 220, 410, and 510 as applicable to installation, and construction of interior building lighting fixtures.

J. NEMA Compliance: Comply with applicable requirements of NEMA Standards Publication Numbers LE1 and LE2 pertaining to lighting equipment and LE4 pertaining to recessed luminaires.

K. IES Compliance: Comply with IES RP-1 pertaining to office lighting practices and RP-15, regarding selection of illuminance values for interior office building.

L. UL Compliance: Comply with UL Standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled.

M. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballasts Manufacturer's Association Standards and carries the CBM label.

N. NECA/IESNA Compliance: Comply with NECA/IESNA 500 – 1998 Standard, Installing Indoor Commercial Lighting Systems (ANSI).

1.6 COORDINATION

A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction. Provide plaster frames, hangers, trim rings, and fittings, as required for each type of ceiling construction.

B. The Contractor shall coordinate switch and lighting control devices with door swings and other architectural features.

C. The Contractor shall be responsible for providing the required quantity of ballasts to provide the control and operations of the lighting fixtures as indicated by the lighting controls on the Drawings. For example, where two switches are indicated to serve fixtures, then two ballasts per fixture shall be provided.

1.7 WARRANTY

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

B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than 5 years from date of Substantial Completion.

C. Special Warranties for Fluorescent Ballasts: Written warranty, executed by manufacturer agreeing to replace fluorescent ballasts that fail in materials or workmanship within specified warranty period.

1. Special Warranty Period for Electronic Ballasts: Five years from date of manufacture, but not less than four years from date of Substantial Completion.
2. Special Warranty Period for Electromagnetic Ballasts: Manufacturers' standard warranty, but not less than two years from date of manufacture.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

B. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

C. Plastic Diffusers and Lenses: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

D. Battery and Charger Data: For emergency lighting units.

E. Ballasts: 1 for every 100 of each type and rating installed. Furnish at least one of each type.

F. Globes and Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, products that may be incorporated into the Work include, the products indicated in this Specification.

B. Data listed and model number shown, in this Specification for each fixture type indicate minimum requirements and no exceptions will be made.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

A. Metal Parts: Free from burrs, sharp corners, and edges.

B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.

C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors, frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.
4. Laminated Silver Metallized Film: 90 percent.

E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.

1. Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rhom & Haas, Dupont, or as acceptable. The quality of the raw material must equal or exceed IES, SPI and NEMA Specifications by at least 100%--which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration, embrittlement, or loss of light transmittance for at least 15 years.
2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.
3. Glass used for lenses, refractors, and diffusers in incandescent lighting fixtures shall be tempered for high impact and heat resistance; the glass shall be crystal clear in quality with a transmittance of not less than 88%. For exterior fixtures, use tempered Borosilicate glass, Corning #7740, or as acceptable. For fixtures directly exposed to the elements and aimed above the horizontal with a radiant energy of 4.16 watts per square inch, or greater, use Vycor glass.
4. Where optical lenses are used, they shall be free from spherical and chromatic aberrations and other imperfections which may hinder the functional performance of the lenses.
5. Mechanical: All lenses, louvers, or other light diffusing elements shall be removable, but positively held so that hinging or other normal motion will not cause them to drop out.
6. Cleaning: All lenses shall be turned over to the Owner clean and free of dust.

2.3 LAMP HOLDERS

A. Incandescent: Body - Porcelain, screw shell, nickel-plated brass, prelubricated with silicone compound.

B. Fluorescent: Body - white urea plastic. Contacts: silver-plated phosphor bronze.

2.4 FINISHES

A. Painted Surfaces: Synthetic enamel, with acrylic, alkyd, epoxy, polyester, or polyurethane base, light stabilized, baked on at 350 degree Fahrenheit minimum, catalytically or photo-chemically polymerized after application.

B. Ceiling opening frames shall either be manufactured of non-ferrous metal, or be suitably rust-proofed after fabrication.

C. Selection: Unless otherwise noted, finishes shall be as selected by the Architect.

D. Undercoat: Except for stainless steel, give ferrous metal surfaces a five-stage phosphate treatment or other acceptable base bonding treatment before final painting and after fabrication.

E. Unpainted non-reflecting surfaces shall be satin finished and coated with a stoved clear lacquer to preserve the surface. Where aluminum surfaces are treated with an anodic process, the clear lacquer coating may be omitted.

F. Unpainted Aluminum Surfaces: Finish interior aluminum trims with an anodized coating of not less than 7 mg per square inch, of a color and surface finish as selected by the Architect. Finish exterior aluminum trims with an anodized coating of not less than 35 mg per square inch or a color and surface finish as selected by the Architect.

G. Porcelain Enamel Surfaces: Apply porcelain finishes smoothly. Finish shall be not less than 7.5 mils thick of non-yellowing, white, vitreous porcelain enamel with a reflectance of not less than 85%.

H. Fixtures: Manufacturer's standard, unless otherwise indicated.

1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects.
2. Metallic Finish: Corrosion resistant.

I. White finishes: Minimum of 85 percent reflectance.

2.5 FLUORESCENT LAMP BALLASTS

A. Fluorescent Lamp Ballast Manufacturers: Provide quality ballasts by the Manufacturers listed below. Off-brand/generic ballasts shall NOT be acceptable.

1. Advance.
2. Lutron.
3. General Electric.
4. Valmont.
5. Universal

B. General Requirements: Unless otherwise indicated, features include the following:

1. Designed for type and quantity of lamps indicated at full light output.
2. Conform to UL 935 *Fluorescent - Lamp Ballasts*.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Sound Rating: A.
5. Conform to ANSI C82.1 Specifications for Fluorescent Lamp Ballast.
6. Warranty: Minimum 2 years of warranty after the date of acceptance for all types of ballasts.

C. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Certified Ballast Manufacturer Certification: Indicated by label.
2. Lamp Starting Method: Programmed start.
3. Nominal Ballast Factor: 87 percent, minimum, unless otherwise indicated.
4. Power Factor: 90 percent, minimum.

5. Encapsulation: Without voids in potting compound.
6. Third Harmonic Content of Ballast Current: Less than 10 percent.
7. Conform to IEEE C62.41, Category A.
8. Conform to FCC Regulations, Part 15, Subpart J.
9. Lamp Current Crest Factor shall be less than 1.7.
10. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.

D. Electromagnetic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:

1. Type: Energy saving.
2. Certified Ballast Manufacturer Certification: Indicated by label.
3. Encapsulation: Without voids in potting compound.

E. Ballasts for Compact Lamps in Recessed Fixtures: Unless otherwise indicated, additional features include the following:

1. Type: Electronic or electromagnetic, fully encapsulated in potting compound.
2. Power Factor: 90 percent, minimum.
3. Operating Frequency: 20 kHz or higher.
4. Flicker: Less than 5 percent.
5. Lamp Current Crest Factor: Less than 1.7.
6. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.
7. Third Harmonic Content of Ballast Current: Less than 10 percent.

F. Ballasts for Compact Lamps in Non-Recessed Fixtures: Unless otherwise indicated, additional features include the following:

1. Power Factor: 90 percent, minimum.

2. Ballast Coil Temperature: 65 deg C, maximum.

3. Transient Protection: Comply with IEEE C62.41 for Category A1 locations.

G. Ballasts for Dimmer-Controlled Fixtures: Comply with general and fixture-related requirements above for electronic ballasts.

1. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast.
2. Ballasts shall be capable of operating lamps indicated in a smooth, stable, flicker-free range from full brightness (100%) down to 5% light output.
3. Ballast shall maintain full filament heat throughout the dimming range.
4. Ballast dimming circuitry shall be UL Class 2 fully insulated form ballast input power.

H. Ballasts for Low-Temperature Environments: As follows:

1. Temperatures 0 Deg F (Minus 17 Deg C) and Above: Electronic or electromagnetic type rated for 0 deg F (minus 17 deg C) starting temperature.

2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Above: Electromagnetic type designed for use with high-output lamps.

I. Ballasts for outdoor environments shall be of the low temperature type (0 degrees Fahrenheit).

J. Ballasts for special applications, as indicated, to minimize EMI/RFI shall comply with 47 CFR, Chapter 1, Part 18, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.6 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

A. General: Comply with ANSI C82.4, "Ballasts for High-Intensity - Discharge and Low-Pressure Sodium Lamps" and UL 1029 "High Intensity Discharge Lighting Fixtures". Unless otherwise indicated, features include the following:

1. Type: Constant wattage autotransformer or regulating high-power-factor type, unless otherwise indicated.
2. Operating Voltage: Match system voltage.
3. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single lamp ballasts.
4. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
5. Open-circuit operation that will not reduce average life.
6. Auxiliary, Instant-on, Quartz Time Delay System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.

B. High-Pressure Sodium Ballasts: Equip with a solid-state igniter/starter having an average life in pulsing mode of 10,000 hours at an igniter/starter case temperature of 90 deg C.

C. Instant Restrike Device: Solid-state, potted module, mounted inside high-pressure sodium fixture and compatible with high-pressure sodium lamps, ballasts, and sockets up to 150 W.

1. Restrike Range: 105- to 130-V ac.
2. Maximum Voltage: 250-V peak or 150-V ac RMS.

D. Ballasts shall be acceptable and listed by Underwriters' Laboratories, Inc. as Type 1 for non-weatherproof indoor conditions, and Type 2 for outdoor conditions; and ballasts shall be CBM-certified by ETL labels. Ballasts shall be high power factor, high efficiency and constant wattage.

E. Operating Environment: Indoor heated or air conditioned spaces - 10°C to 40°C (50°F to 105°F) ambient. Outdoors or unheated spaces: -29°C to 40°C (-20°F to 105°F). Insulation: Class H, 180°C (375°F) when tested in accordance with UL and CBM Standards.

F. Electrical Characteristics: Ballasts shall be designed for single frequency operation , 60 Hz nominal and shall operate at the nominal voltages indicated on the label, 120 volt and/or 277 volt, as required. Drop-out voltages: 66 percent of nominal. Suitable to operate within plus or minus 10 percent voltage variation.

G. Secure ballasts firmly in lighting fixtures to prevent vibrations.

2.7 EMERGENCY BATTERY PACKS:

A. Unless otherwise indicated, features include the following:

1. Conform to UL 924 “Emergency Lighting and Power Equipment”
2. Conform to NFPA 101 and International Building Code (IBC) requirements.
3. Initial Light Output: Provide as indicated.
4. Illumination time: 90 minutes, minimum.
5. Battery: Long life, high temperature, maintenance-free Nickel-Cadmium battery with test switch.
6. Self-Testing Diagnostics: Provide as indicated.
7. Cold Weather Operation: Provide as indicated.
8. Warranty: Minimum 5 year full product warranty.
9. Manufacturers: Provide specification grade emergency battery ballasts by the Manufacturers listed below. Off-brand/generic ballasts shall NOT be acceptable.

a. Bodine
b. Power Sutry
c. Iota

2.8 EXIT SIGNS

A. General Requirements: Comply with UL 924, “Emergency Lighting and Power Equipment”, and the following:

1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.

B. Internally Lighted Signs: As follows:

1. Lamps for AC Operation: Light-emitting diodes (LED), 25 + years rated lamp life.

2.9 LAMPS

A. Fluorescent Color Temperature and Minimum Color-Rendering Index: 3500K and 85 CRI, unless otherwise indicated.

1. Fluorescent Lamps - Outdoor: High output, cool white, lengths as required.

B. Noncompact Fluorescent Lamp Life: Rated average is 20,000 hours at 3 hours per start when used on rapid-start circuits.

C. Metal-Halide Color Temperature and Minimum Color-Rendering Index: 3600 K and 70 CRI, unless otherwise indicated.

D. Incandescent Lamps:

1. A Style, inside frosted, 130 Volt, unless otherwise indicated.
2. Tungsten Halogen PAR lamps.

E. Lamps shall conform to ANSI Standards C78 series and shall be as manufactured by General Electric, Philips, or Sylvania.

F. Lamps installed in outdoor environments shall be rated for low temperature applications (0°F, minimum).

2.10 FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Common Work Results for Electrical" and Division 26 Section "Hangers and Supports", for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (12-mm) steel tubing with swivel ball fitting and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (12-mm) steel tubes with single canopy arranged to mount a single fixture. Finish same as fixture.

D. Rod Hangers: 3/16-inch- (5-mm-) minimum diameter, cadmium-plated, threaded steel rod.

E. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

F. Aircraft Cable Support: Use cable, anchorages, and intermediate supports recommended by fixture manufacturer.

G. Recessed fixtures shall be removable from below to allow access to outlet/junction boxes in ceiling spaces.

H. Each fixture shall be supplied with necessary straps, supports, or hangers, or other miscellaneous materials and devices to install them in a satisfactory manner to conform to architectural treatment and finishes in area in which they are to be installed. Consult all Mechanical, Architectural and Structural Plans and related Contract Documents to be familiar with all necessary details for proper fixture placement. Failure to do so will not relieve the Contractor of responsibility of furnishing all necessary material, complete to perform function intended for indicated lighting system.

2.11 INTERIOR FIXTURES

A. Fixture: Type A

1. Voltage: 277V-AC.
2. Mounting: Suspended, fully adjustable 50" plated aircraft cables with safety stop.
3. Nominal Dimensions: 8 ¼" x 4' x 2 ½ ".
4. Lamp: (1) 54 Watt T5 HO fluorescent.
5. Ballast Type and Features: 0-10 Volt dimming electronic ballast. Ballast factor equal to or greater than 1.0 and total harmonic distortion less than 10%. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: White painted reflector and semi-specular baffle.
7. Construction: Body shall be 20-gauge die-formed steel with 18-guage die-formed internal joiner system, with factory installed plug together wiring. All components shall be hard-tooled to a tolerance of 0.010". Reflectors shall be 91% reflective white die-formed pre-painted aluminum. Fixture shall have factory installed level and lock assembly, which allows side-to-side fixture leveling and locks in place.
8. Manufacturers:

    a. Peerless Bruno Indirect/Direct Series.
    b. Finelite Series 14
    c. Linear Series SP27

B. Fixture: Type A1

1. Voltage: 277V-AC.
2. Mounting: Suspended, fully adjustable 50" plated aircraft cables with safety stop.
3. Nominal Dimensions: 8 ¼" x 4' x 2 ½ ".
4. Lamp: (1) 54 Watt T5 HO fluorescent.
5. Ballast Type and Features: 0-10 Volt dimming electronic ballast. Ballast factor equal to or greater than 1.0 and total harmonic distortion less than 10%. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: White painted reflector and semi-specular baffle.
7. Construction: Body shall be 20-gauge die-formed steel with 18-guage die-formed internal joiner system, with factory installed plug together wiring. All components shall be hard-tooled to a tolerance of 0.010". Reflectors shall be 91% reflective white die-formed pre-painted aluminum. Fixture shall have factory installed level and lock assembly, which allows side-to-side fixture leveling and locks in place.

8. Other features: Factory installed low-profile 1400 lumen emergency battery pack with self-diagnostics.
9. Manufacturers:

    a. Peerless Bruno Indirect/Direct Series.
    b. Finelite Series 14
    c. Linear Series SP27

C. Fixture: Type B

1. Voltage: MVOLT
2. Mounting: Recessed, lay-in ceiling.
3. Nominal Dimensions: 2’ x 2’ x 3.56”.
4. Lamp: (2) 24 watt T5 HO fluorescent.
5. Ballast Type and Features: Single, electronic, program start ballast. Ballast factor equal to or greater than 1.0 with less than 10% total harmonic distortion. Ballast disconnect means per NEC 2011 410.73 (G) shall be factory or contractor installed on each ballast.
6. Shielding: 20 gauge steel reflectors finished in matte satin white powder coat. .095” thick frosted white acrylic lamp diffusers with linear micro-prism pattern.
7. Finish: Matte satin white polyester powder coat applied over 5-stage pre-treatment.
8. Construction: One piece 20 gauge steel reflector and housing. 20 gauge steel ends form finishing housing. Side access 20 gauge steel ballast compartment.
9. Manufacturers:

    a. Focal Point Aerion 2x2 Series
    b. Lithonia VT Series
    c. Corelite Class Z3 Series
    d. Columbia SER22 Series

D. Fixture: Type B1

1. Voltage: MVOLT
2. Mounting: Recessed, lay-in ceiling.
3. Nominal Dimensions: 2’ x 2’ x 3.56”.
4. Lamp: (2) 24 watt T5 HO fluorescent.
5. Ballast Type and Features: Single, electronic, program start ballast. Ballast factor equal to or greater than 1.0 with less than 10% total harmonic distortion. Ballast disconnect means per NEC 2011 410.73 (G) shall be factory or contractor installed on each ballast.
6. Shielding: 20 gauge steel reflectors finished in matte satin white powder coat. .095” thick frosted white acrylic lamp diffusers with linear micro-prism pattern.
7. Finish: Matte satin white polyester powder coat applied over 5-stage pre-treatment.
8. Construction: One piece 20 gauge steel reflector and housing. 20 gauge steel ends form finishing housing. Side access 20 gauge steel ballast compartment.

9. Other Feature: 1400 lumen emergency battery ballast with self-diagnostics, factory installed.
10. Manufacturers:

    a. Focal Point Aerion 2x2 Series
    b. Lithonia VT Series
    c. Corelite Class Z3 Series
    d. Columbia SER22 Series

E. Fixture: Type C

1. Voltage: 277 Volt.
2. Mounting: Recessed
3. Nominal Dimensions: 7-3/4"' x 10" x 3'
4. Lamps: (1) 39 watt T5 HO Fluorescent.
5. Ballast Type and Features: Single, electronic ballast. Ballast factor equal to or greater than 1.0 and total harmonic distortion less than 10%. Ballast disconnect means per NEC 2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: CNC roll-formed brush anodized .032" aluminum front reflector with specular .024" aluminum back reflector.
7. Finish: Polyester powder coat applied over a 5-stage pre-treatment. Standard Luminaire housing finished in Matte Satin White.
8. Construction: 20 gauge steel housing with 24 gauge steel reflector.
9. Manufacturers:

    a. Focal Point Focus 4 series.
    b. Linear Series WW4.
    c. Mark Lighting Series PPL.

F. Fixture: Type D

1. Voltage: 277 Volt AC.
2. Mounting: Pendant Mount.
3. Nominal Dimensions: 17 ½" x 15"
4. Lamps: (1) 57 Watt TRT Compact fluorescent.
5. Ballast Type and Features: One high power factor electronic less than 10% total harmonic distortion. Ballast disconnect means per NEC2011 Article 410.130 (G)shall be factory or contractor installed on each ballast.
6. Shielding: Framed tempered lens with etched perimeter and clear center surface.
7. Construction: Ribbed acrylic shade. 10' adjustable aviation cable.
8. Manufacturers:

    a. FC Lighting FCP 660 Series.
    b. Contech CG Series.
    c. Lightolier Pendalyte Series.
    d. Beta-Calco Belora 22 Series.

G. Fixture: Type D1

1. Voltage: 277 Volt AC.
2. Mounting: Pendant Mount.
3. Nominal Dimensions: 17 ½" x 15"
4. Lamps: (1) 57 Watt TRT Compact fluorescent.
5. Ballast Type and Features: One high power factor electronic less than 10% total harmonic distortion. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: Framed tempered lens with etched perimeter and clear center surface.
7. Construction: Ribbed acrylic shade. 10' adjustable aviation cable.
8. Other Features: Factory installed 1400 lumen emergency battery pack with self-diagnostics.
9. Manufacturers:

    a. FC Lighting FCP 660 Series.
    b. Contech CG Series.
    c. Lightolier Pendalyte Series.
    d. Beta-Calco Belora 22 Series.

H. Fixture: Type E – Not Used

I. Fixture: Type F

1. Voltage: MVOLT.
2. Mounting: Suspended.
3. Nominal Dimensions: 4-1/4" x 9-3/4"" x 4' (nominal)
4. Lamps: (2) 54 Watt T5 HO Fluorescent.
5. Ballast Type and Features: Single electronic ballast. Ballast factor equal to or greater than 1.0 and total harmonic distortion less than 10%. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: Wide Distribution (WD) illumination. Satin anodized finish straight blade louver. Uplight component provided moderate light to reduce the "cavern effect".
7. Construction: Channel and louvers are formed from cold-rolled, 20-gauge steel. Compact sockets feature rotating collars and enclosed contacts. Louver assembly hinges remain attached and hinge down providing easy access to optical system.
8. Other Features: Factory installed 390-700 lumens (nominal) emergency battery pack with self-diagnostics module. 4' wire guard, zinc coated.
9. Manufacturers:

    a. Lithonia MS5HB Series.
    b. Columbia LHE Series

J. Fixture: Type G

1. Voltage: MVOLT
2. Mounting: Wall surface.
3. Nominal Dimensions: 48” x 4 ½” x 5”
4. Lamps: (2) 32 Watt T8 fluorescent.
5. Ballast Type and Features: Single electronic ballast with less than 10% total harmonic distortion. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: Matte white opal acrylic diffuser
7. Construction: Baked white polyester housing formed from die-formed steel with full end caps.
8. Manufacturers:

    a. Lithonia WC Series
    b. Columbia W Series
    c. Nulite DW Series

K. Fixture: Type H

1. Voltage: 277 Volt
2. Mounting: Surface, wall.
3. Nominal Dimensions: 16 ¼” x 7 ¼” x 9 1/8”
4. Lamps: (1) 42 Watt TRT Compact fluorescent.
5. Ballast Type and Features: Single electronic ballast with less than 10% total harmonic distortion. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast.
6. Shielding: Segmented reflectors for superior and control. Medium throw (MD).
7. Construction: Rugged, die-cast, single piece aluminum housing. Die-cast doorframe with 1/8” tempered glass lens. Fully gasketed, one-piece solid silicone.
8. Other Feature: Factory installed emergency battery pack (0° min. operating temp.) with self-diagnostics module.
9. Manufacturers:

    a. Lithonia WST Series
    b. FC Lighting FCW Series
    c. LSI GBWM Series

L. Fixture: Type J

1. Voltage: MVOLT.
2. Mounting: Ceiling Recessed.
3. Nominal Dimensions: 12-3/8” x 13-1/4” x 9-1/2”.
4. Lamps: (1) 42 Watt TRT fluorescent.
5. Ballast: Single, electronic, less than 10% total harmonic distortion and end of life protection.

6. Optical System: Clear semi-specular open reflector maximize lumen output and provide superior glare control.
7. Construction: Extruded socket housing attaches via keyhole mount provides superior heat dissipation and extended lamp life. Galvanized steel mounting frame with mechanical tri retention (clips) ensures secure and flush reflector mounting to ceiling. Frames equipped with galvanized junction box UL listed for through wire applications.
8. Other Feature: Factory installed emergency battery pack (0° min. operating temp.) with self-diagnostics module.
9. Manufacturers:

    a. Lithonia 8VF Series.
    b. Omega OM8 Series.
    c. Presclite CFT8 Series

M. Fixture: Type J1

1. Voltage: MVOLT.
2. Mounting: Ceiling Recessed.
3. Nominal Dimensions: 12-3/8” x 13-1/4” x 9-1/2”.
4. Lamps: (1) 42 Watt TRT fluorescent.
5. Ballast: Single, electronic, less than 10% total harmonic distortion and end of life protection.
6. Optical System: Clear semi-specular open reflector maximize lumen output and provide superior glare control.
7. Construction: Extruded socket housing attaches via keyhole mount provides superior heat dissipation and extended lamp life. Galvanized steel mounting frame with mechanical tri retention (clips) ensures secure and flush reflector mounting to ceiling. Frames equipped with galvanized junction box UL listed for through wire applications.
8. Other Feature: Factory installed emergency battery pack (0° min. operating temp.) with self-diagnostics module. Include sloped ceiling adapter.
9. Manufacturers:

    a. Lithonia 8VF Series.
    b. Omega OM8 Series.
    c. Presclite CFT8 Series

N. Fixture: Type J2

1. Voltage: MVOLT.
2. Mounting: Ceiling Recessed.
3. Nominal Dimensions: 12-3/8” x 13-1/4” x 9-1/2”.

4. Lamps: (1) 42 Watt TRT fluorescent.
5. Ballast: Single, electronic, less than 10% total harmonic distortion and end of life protection.
6. Optical System: Clear semi-specular open reflector maximize lumen output and provide superior glare control. Clear polycarbonate lens.
7. Construction: Extruded socket housing attaches via keyhole mount provides superior heat dissipation and extended lamp life. Galvanized steel mounting frame with mechanical tri retention (clips) ensures secure and flush reflector mounting to ceiling. Frames equipped with galvanized junction box UL listed for through wire applications.
8. Other Feature: Factory installed emergency battery pack (0° min. operating temp.) with self-diagnostics module.
9. Manufacturers:

    a. Lithonia 8VF Series.
    b. Omega OM8 Series.
    c. Presclite CFT8 Series

O. Fixture: Type K

1. Voltage: 277V-AC.
2. Mounting: Under cabinet
3. Nominal Dimensions: 5” x 1.1” x 12”.
4. Lamp: (1) 14 watt T5 fluorescent.
5. Ballast Type and Features: Single rapid start electronic with less than 10% total harmonic distortion. Ballast disconnect means per NEC2011 Article 410.130 (G) shall be factory or contractor installed on each ballast
6. Shielding: High impact, extruded wraparound opal diffuser – 100% DR acrylic. Nominal thickness 0.065”. Pliable non-yellowing lens material.
7. Construction: Solid front 20-gauge steel with white TGIC polyester powder coat finish, 92% reflectance.
8. Manufacturers:

    a. Kenall UCSL Series
    b. Alkco SFHP Series
    c. Nulite 114 Series

P. Fixture: Type L

1. Voltage: 120 Volt.
2. Mounting: Recessed, Adjustable Downlight
3. Nominal Dimensions: 19-5/8” x 11-3/8” x 6-1/2”.
4. Lamp: (1) 65W BR30.

5. Features: Accepts one (1) 75W ER30/PAR30 or 65W BR30 lamp. Porcelain socket with nickel plated copper screw shell. Integral thermal protector against misuse of insulation materials and improper lamping. Adjustable lamp direction in 368° rotation and 0-42° tilt with positive locking mechanism is socket bracket.
6. Construction: Architectural / Commercial grade 6" aperture. Black painted steel housing.
7. Manufacturers:

    a. Con-tech RA6130 Series
    b. A-Line A6801 Series
    c. Image MAH600 Series

Q. Fixture: Type M

1. Voltage: 120 Volt
2. Mounting: Recessed, Downlight.
3. Nominal Dimensions: 15-7/8" x 11".
4. Lamps: (1) 65W PAR38.
5. Features: Self-flanged, semi-specular. 6" open reflector. Die-cast aluminum lampholder housing. Medium-base porcelain socket with nickel-plated screw shell. Thermally-activated insulation detector.
6. Construction: 16-guage steel mounting/plaster frame with adjustable yoke and termpered steel flat spring to retain optical system. 16-gauge galvanized steel mounting bars with 4" vertical adjustment.
7. Aperture and Trim: White painted aperture, white painted flange.
8. Manufacturers:

    a. Gotham 6" APR Series.
    b. Lithonia 6" 6VI Series.
    c. Con-tech RA6150 Series

R. Fixture: Type M1

1. Voltage: 120 Volt
2. Mounting: Recessed, Downlight.
3. Nominal Dimensions: 15-7/8" x 11".
4. Lamps: (1) 65W PAR38.
5. Features: Self-flanged, semi-specular. 6" open reflector. Die-cast aluminum lampholder housing. Medium-base porcelain socket with nickel-plated screw shell. Thermally-activated insulation detector.
6. Construction: 16-guage steel mounting/plaster frame with adjustable yoke and termpered steel flat spring to retain optical system. 16-gauge galvanized steel mounting bars with 4" vertical adjustment.
7. Aperture and Trim: Black painted aperture, black painted flange.

8. Manufacturers:

    a. Gotham 6" APR Series.
    b. Lithonia 6" 6VI Series.
    c. Con-tech RA6150 Series

S. Fixture: Type N

1. Voltage: 120 Volt
2. Mounting: Surface, Track.
3. Nominal Dimensions: 11/16" x 1-3/8" x 8'.
4. Features: Low profile track cross-section. Mechanical polarity with visual indicator. 1 circuit track.
5. Construction: Solid copper conductors with insulators placed in 14 gauge extruded aluminum channels. Strong "H" design construction.
6. Finish: White.
7. Manufacturers:

    a. Con-tech LT Series.
    b. Lithonia LT Series.
    c. Hubbell Prescolite Architrak Series

T. Fixture: Type N1

1. Voltage: 120 Volt
2. Mounting: Surface, Track.
3. Nominal Dimensions: 11/16" x 1-3/8" x 4'.
4. Features: Low profile track cross-section. Mechanical polarity with visual indicator. 1 circuit track.
5. Construction: Solid copper conductors with insulators placed in 14 gauge extruded aluminum channels. Strong "H" design construction.
6. Finish: White.
7. Manufacturers:

    a. Con-tech LT Series.
    b. Lithonia LT Series.
    c. Hubbell Prescolite Architrak Series

U. Fixture: Type N2

1. Voltage: 120 Volt
2. Mounting: Surface, Track.
3. Nominal Dimensions: 11/16" x 1-3/8" x 4'.

4. Features: Low profile track cross-section. Mechanical polarity with visual indicator. 1 circuit track.
5. Construction: Solid copper conductors with insulators placed in 14 gauge extruded aluminum channels. Strong "H" design construction.
6. Finish: Black.
7. Manufacturers:

    a. Con-tech LT Series.
    b. Lithonia LT Series.
    c. Hubbell Prescolite Architrak Series.

V. Fixture: Type N-HEAD

1. Voltage: 120 Volt
2. Mounting: Surface, Track.
3. Nominal Dimensions: 4-11/16" x 4-7/16" x 8-1/8".
4. Quantity: twelve (12).
5. Lamp: 65W PAR30, E26 Medium base. Total of 12.
6. Features: Dual-rail yoke design provides a "hi-tech", less bulky look. Sure-set yoke for precise aiming without tools and full 350° rotation.
7. Construction: Die-cast aluminum housing with open back.
8. Finish: White.
9. Filters:

    a. 1 – LF30-A, Glass Colored Filter - Amber.
    b. 1 – LF30-B, Glass Colored Filter - Blue.
    c. 1 – LF30-CL, Glass Colored Filter - Clear.
    d. 1 – LF30-DPE, Glass Colored Filter – Dichroic Peach.
    e. 1 – LF30-G, Glass Colored Filter - Green.
    f. 1 – LF30-LB, Glass Colored Filter – LB, Light Blue.
    g. 1 – LF30-R, Glass Colored Filter - Red.
    h. 1 – LF30-RO, Glass Colored Filter - Rose.
    i. 1 – LF30-Y, Glass Colored Filter - Yellow.
    j. 1 – LF30-73, Spread Lense.
    k. 1 – LF30-LS, Linear Spread Lens.
    l. 1 – LF30-SL, Soft Light.
    m. 1 – LF30-UV, Optivex UV Filter.
    n. 1 – BD30, Barn Door.

10. Manufacturers:

    a. Con-tech CLT8030 Series.
    b. Lithonia LTC Series.
    c. Hubbell Prescolite AKTLF Series.

W. Fixture: Type N-HEAD-1

1. Voltage: 120 Volt
2. Mounting: Surface, Track.
3. Nominal Dimensions: 4-11/16" x 4-7/16" x 8-1/8".
4. Quantity: three (3).
5. Features: Dual-rail yoke design provides a "hi-tech", less bulky look. Sure-set yoke for precise aiming without tools and full 350° rotation.
6. Construction: Die-cast aluminum housing with open back.
7. Finish: Black.
8. Manufacturers:

    a. Con-tech CLT8030 Series.
    b. Lithonia LTC Series.
    c. Hubbell Prescolite AKTLF Series.

X. Fixture: Type P

1. Voltage: 120 Volt
2. Mounting: Surface, Linear.
3. Nominal Dimensions: 1.19" x 1.16" x 42".
4. Features: Small scale linear LED. Adjustable mount. Remote transformer. Dimmable using commonly available low voltage magnetic dimming equipment.
5. Construction: Solid copper conductors with insulators placed in 14 gauge extruded aluminum channels. Strong "H" design construction.
6. Finish: White.
7. Manufacturers:

    a. Winona LED 102 Series.
    b. LSI Crossover LDL2 Series

Y. Fixture: Type P1

1. Voltage: 120 Volt
2. Mounting: Surface, Linear.
3. Nominal Dimensions: 1.19" x 1.16" x 42".
4. Features: Small scale linear LED. Adjustable mount. Remote transformer. Dimmable using commonly available low voltage magnetic dimming equipment.
5. Construction: Solid copper conductors with insulators placed in 14 gauge extruded aluminum channels. Strong "H" design construction.
6. Finish: Black.
7. Manufacturers:

a. Winona LED 102 Series.
b. LSI Crossover LDL2 Series

Z. Fixture: Type Q

1. Voltage: MVOLT.
2. Mounting: Recessed, Downlight
3. Nominal Dimensions: 11" x 13" x 10-3/4".
4. Lamps: (1) 18 Watt TRT fluorescent.
5. Ballast: Single, electronic, less than 10% total harmonic distortion and end of life protection.
6. Optical System: Clear semi-specular open reflector maximize lumen output and provide superior glare control.
7. Construction: Extruded socket housing attaches via keyhole mount provides superior heat dissipation and extended lamp life. Heavy-gauge, die formed galvanized steel mounting frame. Frames equipped with galvanized junction box UL listed for through wire applications.
8. Manufacturers:

a. Lithonia 6VF Series.
b. Omega OM6 Series.
c. Presclite CFT6 Series

AA. Fixture: Type X

1. Voltage: 120/277V-AC.
2. Mounting: Universal (top, end or back mounting.)
3. Nominal Dimensions: 11 ¾" x 7 5/8" x 2".
4. Lamps: LEDs mounted on printed circuit boards. Expected LED life over 25 years. Low energy consumption-less than one watt.
5. Battery: Sealed, maintenance-free nickel-cadmium.
6. Electronics: Low-voltage disconnect, constant-current series charger, current-limiting charger and AC/LV reset (line latch) shall allow battery connection before AC power is applied and prevents battery damage from deep discharge. Brownout protection shall be automatically switched to emergency mode when supply voltage drops below 80% of nominal.
7. Construction: Engineering-grade thermoplastic housing shall be impact-resistant, scratch-resistant, and corrosion-proof. UL94V-0 flame rating. UV-stable resin shall resist discoloration from natural and man-made light sources. Stencil face with universal directional chevron inserts easily removed and reinserted.
8. Other Features: Self-diagnostics.
9. Manufacturers:

a. Lithonia LQM EL N Series.

b. Sure-Lites LPX7-0 Series.
c. Dual-Lite LXU Series.

2.12 EXTERIOR FIXTURES

A. Fixture: Type LL-1

1. Voltage: 120V-AC.
2. Mounting: Stem mounted, ½" galvanized steel staff with copper sleeve and ½" NPT threads.
3. Nominal Dimensions: 14-3/4" x 23-1/2'
4. Lamp: (1) 8 Watt PAR 20 LED.
5. Shielding: Translucent, molded acrylic.
6. Construction: Heavy gauge cast bronze body with spun copper mushroom shaped canopy.
7. Finish: Dark Bronze.
8. Manufacturers:

a. Hydrel 4557 Series.
b. Kim Lighting H70 Series.
c. Hadco MU5 Series.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

B. Support for Fixtures independent of ceiling systems, ducts, and piping.

1. Install a minimum of four support system rods or wires for each fixture from structure above. Locate not more than 6 inches (150 mm) from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

C. Suspended Fixture Support: As follows:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), 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. Continuous Rows: Suspend from cable installed according to fixture manufacturer's written instructions and details on Drawings. Provide alignment fittings as required for uniform, level installation of continuous rows of suspended fixtures.

D. Fixture installations with fixtures supported only by insecure boxes will be rejected. It shall be the Contractor's responsibility to support all lighting fixtures adequately, providing extra steel work for the support of fixtures if required. Any components necessary for mounting fixtures shall be provided by the Contractor. No plastic, composition or wood type anchors shall be used.

E. Setting and Securing: Set units plumb, square, and level with ceiling and walls, and secure according to manufacturer's printed instructions and approved shop drawings.

F. Support for Recessed and Semi-Recessed Fixtures: Installed units may not be supported from suspended ceiling support system. Install ceiling system support rods or wires at a minimum of four rods or wires per fixture located not more than 6 inches from the fixture corners.

1. Fixtures Smaller Than Ceiling Grid: Install a minimum of four rods or wires for each fixture and locate at corner of the ceiling grid where the fixture is located. Do not support fixtures by ceiling acoustical panels.
2. Fixtures of Sizes Less than Ceiling Grid: Center in the acoustical panel. Support fixtures independently with at least two 3/4-inch metal channels spanning and secured to the ceiling tees.
3. Recessed fixtures shall be provided with the proper plaster frame or suitable adapter to receive the finished ceiling construction.
4. Recessed lighting fixtures shall be suitable for the ceiling or wall material and construction in which they will be installed.
5. All recessed incandescent lighting fixtures shall be provided with thermal protection per NEC requirements.
6. Recessed mounted lighting fixtures shall be connected to a junction box with flexible conduit. Final connection to light fixture shall be with heat-resistant wire of the following type:

    a. Recessed fluorescent 120 or 277 volt, No. 12 RHH or THHN.
    b. Recessed incandescent 120 volt, No. 12 AF.

G. Each lighting fixture shall be rigidly supported from the building construction and shall include suspension hangers, devices, and extra steel work for fixture support where required.

1. Support all lighting fixtures adequately. Special supports shall be installed as required.
2. Luminaires shall be furnished with all necessary stems, plaster frames, hangers, for the safe support of the fixture. All supports for fixtures shall be adequate to

support weight of the fixtures. All visible hanging devices and appurtenances shall have the same finish as the fixture unless specifically indicated otherwise.

H. Coordinate with the work of other trades to determine modifications required to make fixtures suitable for ceilings as installed and verify the types of ceiling construction prior to fixture fabrication. Determine that the suspension method and the flange arrangement for the fixtures coordinates with the ceiling type and its suspended system. Fixtures which are shipped to the project and do not fit, or which otherwise do not match the ceiling system, shall be returned for correction at no additional cost.

I. Lamping: Lamp units according to manufacturer's instructions.

J. Installation shall include receiving, checking, storage in a safe and approved area until they are required for installation, unpacking, assembly of separate fixture components where required, and complete wiring and connection including the provision of associated wiring and connection devices such as fittings, hangers, aligners, box covers, and similar hardware which may be required for certain fixtures, but are not detailed or scheduled with the fixtures.

K. Plaster frames or mounting frames shall be provided for all fixtures which require them and shall be suitable for the ceiling construction in which they will be installed.

L. Trim rings shall be painted to match the finish of the adjacent ceiling surface.

M. Fluorescent fixtures shall be shielded from the dimmed areas to eliminate bleed.

N. Fixtures in equipment rooms shall be positioned clear of equipment interference and yet provide adequate light for working around the equipment.

O. All lighting fixtures, when installed, shall be set free of light leaks, warps, dents, or other irregularities.

P. Pendant-type fixtures shall be hung at heights as required, and as shown on the Drawings.

Q. In certain areas shown on the Drawings, the locations of fixtures are approximate only and the exact locations and pendant lengths will be determined for each individual fixture by the Owner's Representative.

R. Install all lamps required, including replacements for burned out lamps, until final acceptance of the completed work. No lighting fixture or sign will be installed without lamps.

S. If permanent lighting fixtures are to be used in lieu of temporary lighting facilities during the construction period, this shall be done only as permitted by the Owner's Representative, who may require that new lamps be installed and fixtures cleaned at the time of turnover to the Owner.

T. Lighting fixtures for general illumination, emergency lighting, and exterior lighting, shall be complete with all required accessories and attachments.

U. Fixtures shall bear UL label and shall be wired and installed in full compliance with applicable codes.

V. The omission of a type or quantity in this Specification shall not relieve the Contractor of the responsibility of installing all required fixtures, of proper type, as shown on the Drawings.

W. Fixtures shall be recessed, surface, or pendant type, as specified and shall include sockets, diffusers, ceiling canopies and stems, hickeys, and all other necessary accessories.

X. Where suspended ceilings with steel channels occur, outlets and fixtures shall be supported on members resting on the channel framework. In no case shall fixtures be supported from plasterboard, plaster, or acoustic material.

3.2 GENERAL INSTALLATION OF FIXTURES

A. Install interior lighting fixtures at locations and heights as indicated, in accordance with fixture manufacturer's written instructions, applicable requirements of NEC, NECA's *Standard of Installation*, NEMA Standards, and with recognized industry practices to ensure that lighting fixtures fulfill requirements.

B. All recessed fixtures mounted in dry wall or plaster ceilings shall be complete with a suitable plaster frame or trim ring. All fixtures shall be mounted on or in ceilings in accordance with published recommendations of the manufacturers using bar or swing-way hangers, etc. These items shall be furnished as part of the fixture whether called for by catalog number or not.

C. All fixtures shall be installed in strict accordance with NEC Article 410 and shall properly and suitably support the weight of any fixture installed. All fixtures shall be supported independently of ceiling suspension system being attached to building structure.

D. Fixtures indicated to be pendant-mounted shall be suspended with single stem hanger, maximum 40" on center. Hangers shall have suitable means for vertical adjustment and built-in positive horizontal leveling provisions.

E. Regardless of catalog number in lighting fixture schedule, every fixture shall be of the type for the ceiling construction in or on which it is to be installed. It shall be the Electrical Contractor's responsibility to coordinate this with the Ceiling Contractor.

F. All fluorescent lighting fixtures having exposed (bare) lamps shall be provided with safety sleeves (one per each lamp). Sleeves shall be "Arm-a-lite", as manufactured by Thermoplastic Process, Inc., or approved equal. Fixtures with wire guards and/or shielding (louvers, baffles, lenses) beneath the lamps shall not be considered as exposed.

G. Install flush-mounted fixtures properly to eliminate light leakage between fixture frame and finished surface.

H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standards 486A and B, and the National Electrical Code.

3.3 CONNECTIONS

A. Ground equipment. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

B. Advance Notice: Give dates and times for field tests.

C. Provide instruments to make and record test results.

D. Tests: As follows:

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
3. Verify normal transfer to battery source and retransfer to normal.
4. Report results in writing.

E. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

F. Corrosive Fixtures: Replace during warranty period.

3.5 CLEANING AND ADJUSTING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

B. Adjust aimable fixtures to provide required light intensities.

C. Touch up luminaire finish at completion of work.

D. Replace all burned-out / non-operating lamps at the time of substantial completion.

E. Replace all fluorescent and high intensity discharge lamps that fail within three (3) months of Substantial Completion.

F. Replace all metal halide lamps with noticeable color shift.

G. Replacement Lamps: At the time of substantial completion and prior to field tests, replace lamps in interior lighting fixtures which are observed to be noticeably dimmed after Contractor's use and testing. Furnish stock or replacement lamps as specified in this Section, Paragraph "Extra Materials". Deliver replacement stock as directed. Refer to Division 01 Sections for the replacement/restoration of lamps in interior lighting fixtures, and where used, the temporary lighting prior to time of substantial completion.

3.6 DEMONSTRATION

A. Provide a minimum of four (4) hours of training and demonstration of luminaire operations, setting, aiming, adjustment, and maintenance.

END OF SECTION

DIVISION 27
SECTION 270500
COMMON WORK RESULTS FOR COMMUNICATIONS
TABLE OF CONTENTS

3.14. WALL AND FLOOR PENETRATION
3.15. RECORD DRAWINGS
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3.19. EQUIPMENT BY OTHERS
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3.21. OUTAGES

SECTION 270500 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements" "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Common communications installation requirements.

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.

C. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

D. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

E. Coordinate the work of Division 27 with the work of all construction trades.

F. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

G. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field

conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* as hereinafter specified. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

H. Coordinate incoming cable television raceway with the local cable television company.

I. Coordinate incoming telephone raceway with local telephone utility company. Contractor shall provide required conduit size as determined by the telephone company. Contractor is responsible for contacting and coordination with the telephone company prior to ordering or installing any telephone entrance equipment.

1.3 PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the Division 01 Section, *General Requirements* of the specification.

C. Notify Inspection Authorities to schedule inspections of work.

D. Notify Architect and Engineer in advance of scheduled inspections.

E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections

1.4 EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor’s failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.5 INTERPRETATION OF DOCUMENTS

A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawings and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made by reason of failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Bidder’s part.

B. The locations of products shown on Drawings are approximate. Place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.

C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.

D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.

E. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.

F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with "submittals" specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Architect, Engineer and Owner.

H. Perform the work in a first-class, substantial and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.

I. Contact and coordinate service entrance equipment and layout with local power company prior to ordering or installing any service entrance equipment. Contractor shall furnish and install all incoming raceway and service entrance cables. If the power company plans to install cable and/or conduit, Contractor is responsible for proper coordination of cable, conduit, lug sizes, etc., for proper interface between utility owned/installed equipment and Contractor-installed equipment.

J. The Owner shall make the application for electrical service and pay for all service charges, as coordinated with the Contractor.

1.6 MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

1.7 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.8 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

1. ADA - Americans with Disabilities Act
2. ANSI - American National Standards Institute
3. ASTM - American Society for Testing and Materials
4. CSA - Canadian Standards Association
5. EPA - Environmental Protection Agency
6. FM - Factory Mutual
7. IBC - International Building Code
8. IEEE - Institute of Electrical and Electronics Engineers
9. NEC - National Electrical Code
10. NECA - National Electrical Contractors Association
11. NEMA - National Electrical Manufacturers Association
12. NFPA - National Fire Protection Association
13. OSHA - Occupational Safety and Health Act
14. UL - Underwriters' Laboratories

B. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label.

Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.9 SUBMITTALS

A. Product Data: For sleeve seals.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.10 SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Architect and Engineer to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6) copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.11 SHOP DRAWINGS

A. Prepare and submit shop drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. Items and Systems

Access Doors
Conduit
Firestopping
Identification System
Low Voltage Fuses
Record and Information Booklet
Schedule of Values
Sleeves, Hangers, Supports
Sound Systems
Tests and Reports
Underground Cable
Wiring Devices
Wiring Diagrams

1. Submittals shall include but not be limited to the following information: size, type, functional characteristics, compliance with standards in Division 27, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Documents requirements.

2. Submit for approval any other shop drawings as required by the Engineer. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

E. Submit for approval schematic diagrams of each electrical system installed in the building. Diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in each Main Equipment Room. Deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

F. Submittals shall include Riser Diagrams and Schematic Wiring Diagrams, complete conduit and wire requirements, outlet and junction box sizes and power requirements, for the following systems:

1. As indicated on the drawings or Specifications.

G. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.

H. Prepare and submit a detail schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.

1.12 CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 27. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect or Engineer.

1.13 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where conduits penetrate roofs, flash pipe with Stoneman *Stormtite,* Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install curbs, vent assemblies, and sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer's instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.14 CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 27. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

D. Installing Equipment Foundations (Housekeeping Pads):

1. Provide four (4) inch high concrete foundations (housekeeping pads) for all floor-mounted equipment unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement.
2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.
3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.
4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

1.15 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped. Such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 27 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 27, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition. Where existing insulation is disturbed, replace insulation where removed or

damaged equal to existing, in type, thickness, density, finish and thermal resistance (R-value) value.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

1.16 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."."

1.17 EXCAVATION AND BACKFILLING

A. General:

1. Perform all necessary excavation, or installation of work under Division 27, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.18 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

D. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

E. *Contractor* means the electrical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

F. *Conduits* include conduit, all fittings, identification, and other accessories relative to such conduit.

G. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space or attic.

H. *Exposed* means not installed underground or *concealed* as defined above.

I. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

J. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

K. *Building Line:* Exterior wall of building.

PART 2 - PRODUCTS

2.1 GENERAL ELECTRICAL REQUIREMENTS

A. All electrical work performed under Division 27 shall conform to the applicable requirements of the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA and the local Building Code.

B. Provide other work and services not otherwise included in the Contract Documents which is customarily forwarded in accordance with generally-accepted construction practices.

2.2 SLEEVES FOR PATHWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

   a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.3 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

   a. Advance Products & Systems, Inc.
   b. Calpico, Inc.
   c. Metraflex Co.
   d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM, NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 PLYWOOD BACKBOARDS

A. 4’x8’x 3/4” thick AC grade or better fire-retardant plywood.

B. Backboards shall be painted with a minimum of two coats of flame retardant paint to match adjacent wall color.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both communications equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

F. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.

G. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.

H. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.
2. Do not install outlets, switches, etc., behind casework, cabinets, etc.
3. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
4. Coordinate counter top outlets with drilling of casework/counters.
5. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.

3.3. DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use 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.

3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.7 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on

materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

3.8 PROVISIONS FOR ACCESS

A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.9 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 27 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed conduits equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and conform to ANSI Standards.

H. All exterior roof mounted equipment, and conduits shall be painted to match roof in color as selected by Architect.

I. All exposed conduit, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

3.10 COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

3.11 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.12 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.

D. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section *"Temporary Facilities and Controls"*.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.13 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

E. Submit all test results to the Architect/Engineer for approval.

3.14 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 27 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 27.

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07 Section, *Fire Protection, HVAC & Plumbing Penetration Firestopping.*

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide conduit escutcheons for sleeved pipes in finished areas.

E. Conduit sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.15 RECORD DRAWINGS

A. Upon completion of the electrical installations, the Contractor shall deliver to the Engineer one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.16 WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the General Conditions.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
4. That the entire work shall be water-tight and leak-proof.

3.17 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six(6) copies of the Record and Information Booklet and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manuals – Delaware Technical and Community College Sustainable Energy Training Center - Communications.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to

8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Complete catalog data on each piece of electrical equipment furnished including approved shop drawing.
4. Manufacturer's extended limited warranties on equipment.
5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
6. Provide supplier and subcontractor's names, address, and phone number.
7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.
8. Access panel charts with index illustrating the location and purpose of access panels.
9. Approved Electrical Certificates.
10. Start-up reports for equipment.

D. Submit Record and Information Booklets prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Record and Information booklets be reviewed and approved.

E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.

F. Deliver all instruction materials to the Owner prior to the formal instruction period.

G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.

H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

I. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.

J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

K. Where specified in technical sections, provide longer periods required for specialized equipment.

L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

M. The Operating and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.

N. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

3.18 INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:

1. Mechanical Rooms indicating switchgear assemblies; transformers, panels, piping, mechanical ductwork, mechanical equipment, etc.
2. Electrical Rooms indicating switchgear assemblies; transformers, panels, piping, etc.

B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring of equipment.

D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout drawing shall include, but not be limited to the following:

1. Pad-mounted equipment and equipment connections.
2. Underground conduits, ductbanks, and building penetrations.

E. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:

    a. Clearances for equipment disassembly required for periodic maintenance.
    b. Exterior wall and foundation penetrations.
    c. Fire-rated wall and floor penetrations.
    d. Equipment connections and support details.
    e. Sizes and location of required concrete bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.

5. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, Mechanical, Heating and Ventilating Plans to avoid possible demolition and installation conflicts.

3.19 EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.20 PHASING

A. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities having jurisdiction.

B. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems. Interruptions shall be coordinated with the Owner as to time and duration. The contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.21 OUTAGES

A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.

B. Submit *Outage Request form,* attached at end of this Section, to Owner for approval.

END OF SECTION 270500

OUTAGE REQUEST

DATE APPLIED: _____ BY: _____

DATE FOR OUTAGE: _____ FIRM: _____

START OUTAGE-TIME: _____ DATE:_____

END OUTAGE -- TIME: _____ DATE:_____

AREAS AND ROOMS: _____
FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES ____ NO ___ BY: _____DATE: _____

DATE/TIME-AS REQUESTED: _____ OTHER : _____

OWNER'S PRESENCE REQUIRED: _____

YES: ____ NO: ____ NAME: _____

POINT OF CONTACT: _____ PHONE: _____

DIVISION 27
SECTION 271630
TELEPHONE CONDUIT SYSTEM
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SECTION 271630 - TELEPHONE CONDUIT SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including general and supplementary conditions of Division 01, specification sections apply to this section.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements" "Electrical System Commissioning Requirements" and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. Provide telephone conduit system for telephone and fiber optic service from Verizon to demarcation equipment as indicated on the Contract Drawings.

B. Related Sections include the following:

1. Division 26, Section "Raceways and Boxes"
2. Division 26, Section "Electrical Firestopping"
3. Division 26, Section "Hanger and Supports"
4. Division 26, Section "Grounding and Bonding"

1.3 GENERAL

A. Provide all labor, material, equipment and services necessary for and incidental to the complete installation of the telephone raceway system as described herein.

B. All work under this section is subject to the General Conditions and any Special Requirements for the entire contract.

C. The installation shall conform to all rules, regulations, and codes of local, state and federal authorities having jurisdiction including the National Electrical Code, National Fire Protection Association, and NECA - Standards of Installation.

D. Provide responsibility for coordinating the installation with the local telephone company and verifying with the owner that the planned telephone system and capacity has not changed or is not changing from the initial design.

E. Arrange conduit, raceways, backboards and equipment generally as shown. The contract drawings are diagrammatic and do not show all fittings, elbows, junction boxes, etc.,

required for a complete installation. Provide all such devices as needed or as required to present a neat and fully functional system.

1.4 PERMITS AND FEES

A. Obtain, pay for and deliver all permits, certificates of inspection, etc., required by authorities having jurisdiction. All such certificates shall be delivered to the Owner prior to final acceptance of work.

PART 2 PRODUCTS

2.1 CONDUIT

A. Schedule 40 Rigid Polyvinyl Chloride Conduit (PVC)

1. Provide two (2) 4-inch Schedule 40 PVC from manhole to designate point. Refer to drawing for additional information.
2. Conduit to be a 36" minimum below finished grade.

B. Rigid Galvanized Steel Conduit (RGS)

1. Long Radius Sweep

a. Long Radius Sweep shall have a bend of 6ft. with a radius of 3 ft.
b. Provide two (2) 4-inch rigid metal galvanized steel conduit long radius sweeps.
c. Connect to underground 4-inch Schedule 40 PVC. Turn up at exterior wall.
d. Refer to drawing for additional information.

2. RGS

a. Provide one (1) 4-inch RGS up to 36" x 24" x 12" enclosure.

C. Electrical Metallic Tubing (EMT)

1. Provide one (1) 4-inch EMT conduit from exterior enclosure to backboard installed in caged area.
2. Provide one (1) 4-inch 6 ft. bends with a 3 ft. radius down to backboard in caged area.
3. Refer to drawing for additional information.

2.2 INNERDUCT

A. Provide three (3) 1-1/4" inner duct in one conduit run from manhole to exterior NEMA 4X enclosure.

B. Provide three (3) 1-1/4" inner duct in one conduit run from exterior NEMA 4X enclosure to 12" past EMT at backboard.

C. Provide pull cord. Secure at each end.

PART 3 EXECUTION

3.1 SUPPORTS

A. All conduit, device boxes and other equipment shall be supported as described in Division 26 Section *Raceway and Boxes* for other electrical equipment. Follow all local, state and federal regulations.

3.2 INSTALLATION

A. Conduit stubups and raceways shall be equipped with bushings at each end and left with a nylon pull wire if empty.

B. Telephone service entrance conduit shall be buried a minimum of 36-inches below finished grade, more if required by local codes. Ends of conduit shall be capped and a nylon pull wire left in empty conduit. Taping of conduit ends shall not constitute acceptable capping.

END OF SECTION

DIVISION 27
SECTION 271640
MISCELLANEOUS RACEWAY SYSTEMS
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SECTION 271640 - MISCELLANEOUS RACEWAY SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the contract, including general and supplementary conditions of Division 01, specification sections apply to this section.

B. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.2 SECTION INCLUDES

A. Communications raceway system.

B. Data raceway system.

C. Video raceway system.

D. Sound raceway system.

E. Security raceway system.

1.3 DESCRIPTION OF SYSTEM

A. Provide backboxes, baffles, and conduit to form empty raceway systems.

B. Equipment and wiring will be installed under separate contract by Owner's Special System Contractors.

PART 2 - PRODUCTS

A. Conduit: Minimum size 3/4" unless noted.

B. Backboards: 3/4 inch (19.1 mm) weatherproof plywood, with fire retardant paint. One 4' x 8' piece per location, unless otherwise shown on drawings. Refer to Division 27 Section "Common Work Results for Communications".

C. Outlet Boxes: 4-11/16" x 2-1/8" deep (119 mm x 54 mm) square with single or two (2) gang raised cover in gypsum wallboard walls, or 3-1/2" (84 mm) deep single or multiple gang masonry in masonry walls. Provide single or multiple gang boxes as shown on Drawings.

D. Pull and Junction Boxes: Refer to Division 26 Section "Raceways and Boxes".

E. Floor Boxes: Refer to Division 26 Section "Wiring Devices".

F. Cabinets: Refer to Division 26 Section "Raceways and Boxes".

G. Cover Plates: To match other device plates. Refer to Division 26 Section "Wiring Devices".

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide all raceway components, as required, for complete system. Extend conduits to designation space, i.e. IDF Room or Mechanical Room.

B. Each run of conduit shall contain not more than two 90 degree bends and no run shall exceed 100 ft. in length. Minimum radii for bends: 9-1/2" for 3/4" conduit, 10-1/2" for 1" conduit, and a minimum of ten times the trade size diameter bends for larger sizes. Do NOT use conduit fittings in lieu of bends.

C. Provide bushed fittings on all conduit terminations.

D. Provide pullboxes in conduit runs exceeding 100 feet (30 m) in length, and in runs with more than two right angle bends. Do NOT use conduit fittings in lieu of bends.

E. Identify all cabinets, and pull and junction boxes as to system usage.

F. Provide nylon pull cord in each conduit run.

G. Provide identification tags on all conduit runs.

H. Provide cover plates on all outlet boxes.

I. Provide plywood backboards and duplex receptacles in equipment room(s). Confirm location on job-site prior to installation. Paint all backboards with prime coat of fire resistant paint and finish coat of enamel in color to match wall. In unfinished rooms, provide gray finish

coat.

J. Coordinate all work with Owner and Owner's Special System Contractor.

END OF SECTION

DIVISION 27
SECTION 275116
RESCUE ASSISTANCE TWO-WAY COMMUNICATION SYSTEM
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SECTION 275116 - RESCUE ASSISTANCE TWO-WAY COMMUNICATION SYSTEM

PART 1. GENERAL

1.1. RELATED DOCUMENTS

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

B. Division 26 Section "Conductors and Cables."

C. Division 26 Section "Raceways and Boxes."

D. This project is to be LEED certified. Refer to Division 01 Sections, including “Construction Waste Management”, “General Commissioning Requirements”, “Electrical System Commissioning Requirements”, and “Sustainable Design Requirements” for mandatory work which may apply to all contractors, installers and suppliers.

1.2. SUMMARY

A. Furnish, install, and wire all equipment associated with the installation of an Audio-VisualRescue Assistance Signal System to comply with ADA requirements. This work shall include a callbox, power supply, outlet boxes, cables and wiring as shown on the drawings and as specified herein.

1.3. SUBMITTALS

A. General: Data sheets on all equipment being provide as well as recommended cable types.Internal control cabinet drawings showing internal block diagram connections shall be provided. Wiring diagrams showing typical field wiring connections as well as single line floor plan indicating equipment locations as well as cable routings and quantities.

B. Product Data: Submit product data, including manufacturer's (Spec-Data) product sheet, forspecified products.

C. Shop Drawings: Submit shop drawings showing layout, profiles and product components, including anchorage and accessories. Include cabling diagrams, wiring diagrams, stationinstallation details, and equipment cabinet details.

D. Quality Assurance Submittals: Submit the following:

1. Test Reports: Certified test reports showing compliance with specified performancecharacteristics.
2. Manufacturer's Instructions: Manufacturer's installation instructions.

3. Manufacturer's Field Reports: Manufacturer's field reports specified herein.

E. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See Specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See Specification 018113.

F. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data: Operation and maintenance data for installed productsin accordance with Division 1 Closeout Submittals (Maintenance Data and OperationData) Section. Include methods for maintaining installed products and precautionsagainst cleaning materials and methods detrimental to finishes and performance. Includetroubleshooting guide, wiring terminal identification and equipment parts list.
2. Warranty: Warranty documents specified herein.

G. Project Closeout

1. A one-year maintenance contract offering continue factory authorized service of thissystem shall be provided as part of this contract. As-built drawings that include changesto wiring, wiring designations, junction box labeling and other pertinent information shallbe supplied upon completion of the project.
2. The contractor shall furnish manufacturer's manuals of the completed system includingindividual specifications sheets, schematics, inter-panel and intra-panel wiring diagrams.

    a. All information necessary for the proper maintenance and operation of the systemmust be included.
    b. Provide four copies.

3. As built drawings that include changes to wiring, wiring designations, junction boxlabeling, and other pertinent information shall be supplied upon completion of theproject.Provide a minimum of two (2) hours of in-service training with the system.

    a. These sessions shall be broken into segments that will facilitate the training of the system users in operating station equipment.
    b. Operating manuals and user's guides shall be provided at the time of training.

1.4. WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

1. Warranty Period: One year commencing on the Date of Substantial Completion.
2. All materials and installation shall be guaranteed to be free of defects in material and workmanship for one year after final acceptance of installation and tests.

1.5. INSTALLATION STANDARDS

A. The system shall be installed in accordance with the 2008 NEC and ADA requirements.

B. The completed system shall be in compliance with national, state, and local electrical codes.

C. All wiring shall test free from grounds and shorts.

1.6. SYSTEM OPERATIONS

A. Furnish, install and place into operation a Rescue Assistance System for this building asindicated on the drawings and as specified herein.

PART 2. PRODUCTS

2.1. RESCUE ASSISTANCE-VISUAL EQUIPMENT

A. Manufacturer: RCS Wireless Technology or approved equal.

1. Contact: 800 Megahertz Drive, PO Box 12609, 27117, Winston-Salem, NC 27107

2.2. RCS WIRELESS TECHNOLOGY, CALL24 WIRELESS CALLBOX SYSTEMS

A. Equipment

1. This system shall consist of wireless callbox to match existing campus equipment.
2. Long Range Wireless Interface, Two-Way Voice CommunicationsAutomatic Call Alert Prompts, with Voice Call Box Location ID-to public safety for Push Button, Silent Tamper Alert, Battery Maintenance Test.
3. Grade 2 raised letter & Braille.

4. Call Boxes and Transceivers come already preprogrammed for customer convenience.
5. All Control Board & Voice Alerts, and RF Programmed Included (no additional)Single, Self-Contained 12 VDC Rechargeable Battery to maintain a call box for un-interrupted operationBattery Maintenance Alert (Low battery alert)-4 hour voice repeat interval

B. Callbox

1. The callbox shall be a CALL24 Wireless Callbox System Model C24-10A-MU-CS, or approved equal, surface mounted as shown on the drawings.
2. Provide Blue Strobe and BlueStar LED indicator, flat mount for wall mount installation. Model C24-000568 or approved equal.

2.3. SOURCE QUALITY

A. Source Quality: Obtain rescue assistance equipment and system from a single manufacturer.

PART 3. EXECUTION

3.1. MANUFACTURER'S INSTRUCTIONS

A. Compliance: Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.

3.2. EXAMINATION

A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

3.3. INSTALLATION

A. Cabling Requirements

1. Provide wire in accordance with Division 26 Section "Conductors and Cables."

B. Rescue Assistance Signal System – Audio Installation

1. Complete system shall be installed in strict accordance with manufacturer'srecommendations.
2. Wiring shall be installed in raceways throughout the building. See Division 26 Section"Raceway and Boxes."

3.4. FIELD QUALITY REQUIREMENTS

A. Site Tests (Post Installation Testing): Checkout final connections to the system shall be made by a factory technician authorized by the manufacturer of the products installed.

1. Factory authorized technicians shall demonstrate operation of the complete system andeach major component to the staff.
2. Inspection: Perform a complete functional test of the system upon completion of theinstallation and instruct the staff in the operation and maintenance of the system.

3.5. CLEANING

A. Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance. Remove construction debris from project site and legally dispose of debris.

END OF SECTION

DIVISION 28
SECTION 280500
COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY
TABLE OF CONTENTS

SECTION 280500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY & SECURITY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings 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. Electronic safety and security equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Common electronic safety and security installation requirements.

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all electrical work.

C. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

D. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

E. Coordinate the work of Division 28 with the work of all construction trades.

F. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

G. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with *Submittals* as hereinafter specified. The right is reserved to make

reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

1.3 PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the Division 01 Section, *General Requirements* of the specification.

C. Notify Inspection Authorities to schedule inspections of work.

D. NotifyEngineerin advance of scheduled inspections.

E. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections

1.4 EXAMINATION OF SITE

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.

B. Examine and verify specific conditions described in individual specifications sections.

C. Verify that utility services are available, of the correct characteristics, and in the correct locations.

1.5 MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal, subject to approval by Engineer. Substituted items shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Substituted items, including items other than first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Contractor, by providing other than the first

named manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation. Adjustments and modifications shall include but not be limited to electrical, structural, support, and architectural work.

D. Substitution will not be permitted for specified items of material or equipment where noted.

E. All items of equipment furnished shall have a service record of at least five (5) years.

1.6 DEFINITIONS

A. *EPDM*: Ethylene-propylene-dieneterpolymer rubber.

B. *NBR*: Acrylonitrile-butadiene rubber.

C. *Approve* - to permit use of material, equipment or methods conditional upon compliance with contract documents requirements.

D. *Furnish and install* or *provide* means to supply, erect, install, and connect to complete for readiness for regular operation, the particular work referred to.

E. *Contractor* means the electrical contractor and any of his subcontractors, vendors, suppliers, or fabricators.

F. *Conduits* includes conduit, all fittings, identification, and other accessories relative to such conduit.

G. *Concealed* means hidden from sight in chases, formed spaces, shafts, hung ceilings, embedded in construction or in crawl space.

H. *Exposed* means not installed underground or *concealed* as defined above.

I. *Finished Spaces*: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceiling, unexcavated spaces, crawl spaces, and tunnels.

J. *Review* - limited observation or checking to ascertain general conformance with design concept of the work and with information given in contract documents. Such action does not constitute a waiver or alteration of the contract requirements.

K. *Building Line:* Exterior wall of building.

1.7 SUBMITTALS

A. Product Data: For sleeve seals.

B. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.8 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA and ASTM standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50.

1.9 REFERENCED STANDARDS, CODES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

1. ADA - Americans with Disabilities Act
2. ANSI - American National Standards Institute
3. ASTM - American Society for Testing and Materials
4. CSA - Canadian Standards Association
5. EPA - Environmental Protection Agency
6. FM - Factory Mutual
7. IBC - International Building Code
8. IEEE - Institute of Electrical and Electronics Engineers
9. MDE - Maryland Department of the Environment
10. NEC - National Electrical Code
11. NECA - National Electrical Contractors Association
12. NEMA - National Electrical Manufacturers Association
13. NFPA - National Fire Protection Association
14. OSHA - Occupational Safety and Health Act
15. UL - Underwriters' Laboratories

B. Electrical construction materials shall, where a listing is normal for the particular class of material, be listed in *Electrical Construction Materials List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Electrical equipment shall, where a listing is normal for the particular class of equipment, be listed in the *Electrical Appliance and Utilization Equipment List* of the Underwriters' Laboratories, Inc. (U.L.) and shall bear the listing label. Materials and equipment listed and labeled as "approved for the purpose" by other nationally recognized testing laboratory, inspection agency or approved organization (such as E.T.L. or Factory Mutual) shall be acceptable.

1.10 SUBMITTALS, REVIEW AND ACCEPTANCE

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in best interest of Owner.

B. After acceptance of Material and Equipment List, submit six (6)copies or more as required under General Conditions of complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

C. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

D. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

E. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs and drawings where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action and maintaining the specification requirements if differences have not been clearly indicated in the submittal.

F. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Call attention, in writing, to deviation from contract requirements.

G. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted. Use only final or corrected submittals and data prior to fabrication and/or installation.

H. For any submittal requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return of any reason.

1.11 SHOP DRAWINGS

A. Prepare and submit shop drawings for all electrical equipment, specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the Contract Drawings, or where the proposed installation differs from that shown on Contract Drawings.

B. Submit data and shop drawings including but not limited to the list below, in addition to provisions of the paragraph above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number and drawing number.

C. Every submittal including, but not limited to the list below, shall be forwarded with its own transmittal as a separate, distinct shop drawing. Grouping of items/systems that are not related shall be unacceptable.

D. Items and Systems

Conduit
Fire Alarm System
Firestopping
Identification System
Low Voltage Fuses
Record and Information Booklet
Schedule of Values
Sleeves, Hangers, Supports
Tests and Reports
Underground Cable
Wiring Devices
Wiring Diagrams

1. Submittals shall include but not be limited to the following information: size, type, functional characteristics, compliance with standards in Division 26, required service access which shall be suitable for intended location and use, electrical service connections and requirements, and deviations from Contract Documents requirements.
2. Submit for approval any other shop drawings as required by theEngineer. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

E. Submit for approval schematic diagrams of each electrical system installed in the building. Diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in each Main Equipment Room. Deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

F. Submittals shall include Riser Diagrams and Schematic Wiring Diagrams, complete conduit and wire requirements, outlet and junction box sizes and power requirements, for the following systems:

1. Fire Alarm System
2. Low Voltage Switching System
3. As indicated elsewhere on the drawings or Specifications.

G. For any shop drawing requiring more than two (2) reviews by the Engineer (including those caused by a change in subcontractor or supplier) the Owner will withhold contractor's funds by a change order to the contract to cover the cost of additional reviews. One review is counted for each action including rejection or return for any reason.

H. Prepare and submit a detail schedule of values indicating the Contract costs for the major work items. Provide additional detail and information as requested by the Engineer.

1.12 CUTTING AND PATCHING

A. Accomplish all cutting and patching necessary for the installation of work under Division 28. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing construction and finish, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the Architect.

1.13 PENETRATION OF WATERPROOF CONSTRUCTION

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where conduits penetrate roofs, flash pipe with Stoneman*Stormtite,* Pate or approved equal, roof flashing assemblies with skirt and caulked counter flashing sleeve.

C. Furnish and install pitch pockets or weather tight curb assemblies where required.

D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions. The Contractor shall be responsible for sleeve sizes and locations. All roof penetrations shall be installed in accordance with manufacturer’s instructions, the National Roofing Contractors Association, SMACNA, and as required by other divisions of these specifications.

1.14 CONCRETE AND MASONRY WORK

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 28. Perform work in accordance with requirements of other applicable Divisions of these specifications.

B. Concrete shall test not less than 3,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

D. Installing Equipment Foundations (Housekeeping Pads):

1. Provide four (4) inch high concrete foundations (housekeeping pads) for all floor-mounted equipment unless otherwise noted. Furnish foundations, bolts, sleeves, and appurtenances and set under the section furnishing the equipment. Anchor the concrete foundations by dowels inserted into the floor slab. Provide welded wire fabric reinforcement.
2. Unless otherwise specified, provide all concrete work required in accordance with the requirements of Division 03.
3. Equipment shall be properly aligned. Level and grout equipment where necessary. Support conduit independently of equipment and so as not to cause a strain or thrust.
4. Determine exact location of all equipment, foundations, and supports after Shop Drawings of equipment have been approved.

1.15 CONNECTIONS AND ALTERATIONS TO EXISTING WORK

A. Unless otherwise noted on the drawings, where existing electrical work is removed, including hangers, to a point below finished floors or behind finished walls and capped. Such point shall be far enough behind finished surfaces to allow for installation of normal thickness of required finish material.

B. Where work specified in Division 28 connects to existing equipment, conduits, etc., Contractor shall perform all necessary alterations, cuttings, fittings, etc., of existing work as may be necessary to make satisfactory connections between new and existing work, and to leave completed work in a finished and workmanlike condition.

C. Where the work specified under Division 28, or under other Divisions, requires relocation of existing equipment, conduit etc., Contractor shall perform all work and make necessary changes to existing work as may be required to leave completed work in a finished and workmanlike condition. Where existing insulation is disturbed, replace insulation where removed or damaged equal to existing, in type, thickness, density, finish and thermal resistance (R-value) value.

D. Where the relocation of existing equipment is required for access or the installation of new equipment, the contractor shall temporarily remove and/or relocate and re-install as required to leave the existing and new work in a finished and workman like condition.

1.16 DEMOLITION

A. Unless otherwise noted all existing equipment, conduit, wire, etc., shall remain.

B. Where existing equipment is indicated to be removed, all associated conduit, power, controls, insulation, hangers, supports and housekeeping pads, etc., patch, paint and repair walls/roof/floor to match existing and/or new finishes.

C. The Contractor shall be responsible for visiting the site and determining the existing conditions in which the work is to be performed.

D. Where any abandoned conduits in existing floors, walls, pipe tunnels, ceilings, etc., conflict with new work, remove abandoned conduits as necessary to accommodate new work.

E. The location of all existing equipment, conduits etc., indicated is approximate only and shall be checked and verified. Install all new electrical protection work to connect to or clear existing work as applicable.

F. Maintain egress at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and the authorities having jurisdiction.

G. Make provisions and include in bid all costs associated with confined entry/space requirements in and all other applicable OSHA regulations.

H. Where required to maintain the existing systems in operation, temporarily backfeed existing systems from new equipment. Contractor shall temporarily extend existing conduit systems to new conduit systems.

I. At completion of project all temporary conduit, wires, etc., shall be removed in their entirely.

J. Existing conduit, equipment, wiring, etc., not required for re-use or re-installation in this project, shall be removed from the project site.

K. Deliver to the Owner, on the premises where directed, existing equipment and materials which are removed and which are desired by the Owner or are indicated to remain the property of the Owner.

L. All other materials and equipment which are removed shall become property of the Contractor and shall be promptly removed, from the premises, and disposed of by the Contractor, in an approved manner. Contractor shall be responsible for proper disposal of all removed equipment containing PCB's.

M. Where conduit and wiring are removed, remove all conduit hangers which were supporting the removed conduit. Patch the remaining penetration voids with like materials and paint to match existing construction.

N. Before demolition begins, and in the presence of the Owners representative, test and note all deficiencies in all existing systems affected by demolition but not completely removed by demolition. Provide a copy of the list of system deficiencies to the Owner and the Engineer. Videotape existing conditions in each space prior to beginning demolition work.

O. The Owner shall have the first right of refusal for all fixtures, devices and equipment removed by the Contractor.

P. All devices and equipment designated by the Owner to remain the property of the Owner shall be moved and stored by the Contractor at a location on site as designated by the Owner. It shall be the Contractor's responsibility to store all devices and equipment in a safe manner to prevent damage while stored.

Q. All existing equipment refused by the Owner shall become the property of the Contractor and shall be removed from the site by the Contractor in a timely manner and disposed of in a legal manner.

R. Work Abandoned in Place: cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.

S. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

T. Terminate services and utilities in accordance with local laws, ordinances, rules and regulations.

1.17 EXCAVATION AND BACKFILLING

A. General:

1. Perform all necessary excavation, or installation of work under Division 28, in whatever materials or conditions encountered, using suitable methods and equipment.
2. Accurately establish required lines and grades and properly locate the work.
3. Determine the locations of all existing utilities before commencing the work.

B. Excavation: (Refer also to other portions of the specifications)

1. Excavate only the required elevations. If excavation is carried below the foundation lines or other required limits, backfill the excess with concrete.
2. Keep banks of trenches as nearly vertical as possible, and provide sheeting and/or shoring as required for protection of work and safety of personnel. Follow local, State, OSHA, and MOSHA Guidelines.
3. Keep excavations dry. Protect excavations from freezing.

C. Backfilling: (Refer also to other portions of the specifications)

1. Backfill excavations to the required elevations and restore surfaces to their original or required conditions.
2. Backfill shall be similar material, free from objectionable matter such as rubbish, roots, stumps, brush, rocks and other sharp objects. Unless otherwise indicated, suitable material from the excavation may be used for backfill.
3. Carefully place and mechanically tamp backfill in layers not exceeding 12 inches loose thickness. Compact to 95 percent minimum.
4. Do not backfill against frozen material. Do not use frozen material for backfill.

1.18 COORDINATION

A. Coordinate arrangement, mounting, and support of electronic safety and security equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electronic safety and security items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section “Penetration Firestopping”.

PART 2 - PRODUCTS

2.1 GENERAL ELECTRICAL REQUIREMENTS

A. All electrical work performed under Division 26 shall conform to the applicable requirements of the National Electric Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA and the Local Building Code.

B. Provide other work and services not otherwise included in the Contract Documents which is customarily forwarded in accordance with generally-accepted construction practices.

2.2 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.3 SLEEVE SEALS

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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM,NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
3. Pressure Plates: Carbon steel. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.4 PLYWOOD BACKBOARDS

A. 4'x8'x 3/4" thick AC grade or better fire-retardant plywood.

B. Backboards shall be painted with a minimum of two coats of flame retardant paint to match adjacent wall color.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRONIC SAFETY AND SECURITY INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electronic safety and security equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

F. Verify exact electrical service requirements for each piece of equipment receiving electrical connections. Provide proper service for each.

G. Include any and all items required by the National Electrical Code and/or field conditions for the proper connection and installation of each piece of equipment.

H. Coordinate electrical work with architectural items and equipment by others. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.

3.3 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified videographer to record demonstration and training video recordings. Record each training module separately.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Video Recording Format: Provide high-quality color video recordings with menu navigation in format acceptable to Engineer

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.

D. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

E. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.

3.4 SLEEVE INSTALLATION FOR ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants.".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 26 Section "Electrical Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steelor cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.6 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electronic safety and security installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 26 Section "Electrical Firestopping."

3.7 SUPPORTS, HANGERS AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports, hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

3.8 PROVISIONS FOR ACCESS

A. The Contractor shall provide access panels and doors for all concealed equipment, and other devices requiring maintenance, service, adjustment or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of liftout ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.9 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exterior equipment and conduits shall be painted to match adjacent surface in color as selected by Architect.

H. All exposed conduit, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards. Conduit to maintain galvanized finish. Request permission from Architect if touch up is required.

3.10 COLOR SELECTION

A. Color of finishes shall be as selected by the Architect.

3.11 PROTECTION OF WORK

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduits and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver conduits with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored conduits from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.12 OPERATION OF EQUIPMENT

A. Clean all systems and equipment prior to initial operation for testing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing.

D. Do not use electrical systems for temporary services or during construction, unless approved by Owner in writing. Refer to Division 01 Section *"Temporary Facilities and Controls"*.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items.

3.13 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

E. Submit all test results to the Engineer for approval.

3.14 WALL AND FLOOR PENETRATION

A. All penetrations of partitions, ceilings, roofs and floors by or conduit under Division 28 shall be sleeved, sealed, and caulked airtight for sound and air transfer control.

B. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 26.

C. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 26 Section, *Electrical Firestopping.*

D. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

E. Provide conduit escutcheons for sleeved pipes in finished areas.

F. Conduit sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.15 RECORD DRAWINGS

A. Upon completion of the electrical installations, the Contractor shall deliver to the Engineer one complete set of prints of the electrical Contract Drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.16 WARRANTY

A. Contractor's attention is directed to warranty obligations contained in the General Conditions.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two year period from the time of final acceptance by the Owner:

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the Contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.

4. That the entire work shall be water-tight and leak-proof.

3.17 OPERATIONS AND MAINTENANCE MANUALS

A. The Contractor shall have prepared six(6) copies of the Operations and Maintenance Manual and deliver these copies of the manual to the Owner. The manual shall be as specified herein. The manual must be approved and will not be accepted as final until so stamped.

B. The manual shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manuals – Delaware Technical & Community College Sustainable Energy Training Center – Electronic Safety and Security.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the manual:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
3. Complete catalog data on each piece of electrical equipment furnished including approved shop drawing.
4. Manufacturer's extended limited warranties on equipment.
5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
6. Provide supplier and subcontractor's names, address, and phone number.
7. Catalog data of all equipment, starters, etc. shall include wiring diagrams, parts list and assembly drawing.
8. Access panel charts with index illustrating the location and purpose of access panels.
9. Approved Electrical Certificates.
10. Start-up reports for equipment.

D. Submit Operations and Maintenance Manuals prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Operations and Maintenance Manuals be reviewed and approved.

E. Post one (1) copy of all instructions, lists, charts and diagrams at the equipment mounted under glass or approved plastic cover.

F. Deliver all instruction materials to the Owner prior to the formal instruction period.

G. Upon completion of all work, thoroughly instruct the Owner's representatives in the proper operation and maintenance of all electrical equipment and systems.

H. Instructions shall be done only after completed systems have been put into operation and tested for proper operation and performance.

I. Instructions shall be given only by experts in the equipment or system and shall include descriptions and demonstrations of procedures of operation, data record keeping, etc.

J. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project for one 8-hour day.

K. Where specified in technical sections, provide longer periods required for specialized equipment.

L. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

M. The Operating and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.

N. Schedule the general and specialized instruction periods for a time agreed upon by the Owner and Engineer.

3.18 INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:

1. Mechanical Rooms indicating switchgear assemblies; transformers, panels, piping, mechanical ductwork, mechanical equipment, etc.
2. Electrical Rooms indicating switchgear assemblies; transformers, panels, piping, etc.

B. Draw plans to a scale not less than ¼ inch equals one foot. Include plans, sections and elevations of the proposed work, showing all equipment (mechanical, plumbing and electrical), conduit and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring of equipment.

D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout drawing shall include, but not be limited to the following:

1. Underground conduits, ductbanks, and building penetrations.

E. Prepare scaled coordination drawings in accordance with the Specifications. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of power, lighting, and all special system raceways, equipment, and materials. Include the following:

    a. Clearances for equipment disassembly required for periodic maintenance.
    b. Exterior wall and foundation penetrations.
    c. Fire-rated wall and floor penetrations.
    d. Equipment connections and support details.
    e. Sizes and location of required concrete bases.

2. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction, including, but not limited to, the following: Major conduits and feeders.
3. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
4. The successful Bidder shall be responsible for indicating all raceways described in notes or indicated by home run symbols.
5. The successful Bidder shall check all trades' Drawings, including Civil, Architectural, Structural, Plumbing, Mechanical, Heating and Ventilating Plans to avoid possible demolition and installation conflicts.

3.19 EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions or furnished by the Owner. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will not relieve the Contractor of any responsibility for improper equipment operation.

3.20 PHASING

A. Maintain building egress and traffic ways at all times. Coordinate egress requirements with the State Fire Marshal, the Owner and Authorities having jurisdiction.

B. Provide dust barriers/partitions, penetration closures, etc, to ensure safety of building occupants and protection of existing surroundings.

C. The Building shall remain watertight at all times.

D. While work is in progress, except for designated short intervals during which connections are made, continuity of service shall be maintained to all existing systems.

Interruptions shall be coordinated with the Owner as to time and duration. The contractor shall be responsible for any interruptions to service and shall repair any damages to existing systems caused by his operations.

3.21 OUTAGES

A. Provide a minimum of fourteen (14) days notice to schedule outages. The Contractor shall include in their bid outages and/or work in occupied areas to occur on weekends, holidays, or at night. Coordinate and get approval of all outages with the Owner.

B. Submit *Outage Request Form*, attached at end of this Section, to Owner for approval.

END OF SECTION

OUTAGE REQUEST

DATE APPLIED: ___BY: _____

DATE FOR OUTAGE: FIRM: _____

START OUTAGE-TIME: DATE:_____

END OUTAGE -- TIME: DATE:_____

AREAS AND ROOMS: _____
FLOOR(S): _____

AREA(S): _____

ROOM(S): _____

WORK TO BE PERFORMED: _____

SYSTEM(S): _____

REQUEST APPROVED BY: _____
(FOREMAN OR OTHER PERSON IN CHARGE)

(FOR OWNER'S USE ONLY):

APPROVED: _____

YES NO BY: ___DATE: _____

DATE/TIME-AS REQUESTED: OTHER :_____

OWNER'S PRESENCE REQUIRED: _____

YES: NO: NAME: _____

POINT OF CONTACT: PHONE: _____

DIVISION 28
SECTION 283117
FIRE ALARM SYSTEM
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SECTION 283117 - FIRE ALARM SYSTEMS

PART 1 -– GENERAL

1.1. SUMMARY

A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:

1. Fire alarm and detection operations
2. Control and monitoring of smoke control equipment, door hold-open devices, fire suppression systems, and other equipment as indicated in the drawings and specifications.

1.2. ACCEPTABLE MANUFACTURERS

A. Manufacturers: The equipment and service described in this specification are those supplied and supported by Simplex and represent the base bid for the equipment.

1.3. RELATED DOCUMENTS

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

B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

1. Division 28 Section, “Common Work Results for Electrical Safety and Security.”
2. Division 26 Section, “Electrical Firestopping.”
3. Division 21 Section, “Fire Protection”
4. Division 23 Section, “HVAC Systems”

C. The system and all associated operations shall be in accordance with the following:

1. Guidelines of the following Building Code: IBC (current edition)
2. NFPA 72, National Fire Alarm and Signaling Code (current edition)
3. NFPA 70, National Electrical Code (current edition)
4. NFPA 101, Life Safety Code (current edition)
5. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems (current edition)
6. Local Jurisdictional Adopted Codes and Standards

7. ADA Accessibility Guidelines

D. This project is to be LEED certified. Refer to Division 01 Sections, including "Construction Waste Management", "General Commissioning Requirements", "Electrical System Commissioning Requirements", and "Sustainable Design Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.4. SYSTEM DESCRIPTION

A. General: Provide a complete, non-coded, addressable, microprocessor-based fire alarm system with initiating devices**,** notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory.

C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

D. Wiring/Signal Transmission:

1. Transmission shall be addressable signal transmission, dedicated to fire alarm service only.
2. System connections for initiating (signaling) circuits and notification appliance circuits shall be Class B.
3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

E. Required Functions: The following are required system functions and operating features:

1. Priority of Signals: Alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Supervisory and Trouble events have second-, and third-level priority respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
2. Noninterfering: The activation of an addressable device does not prevent the receipt of signals from subsequent activations.
3. Transmission to Remote Central Station: Automatically route alarm, supervisory, and trouble signals to a remote central station service transmitter provided under another contract.
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP and the remote annunciator, indicating the location and type of device.

5. General Alarm: A system general alarm shall include:

    a) Indication of alarm condition at the FACP and the annunciator(s).
    b) Identification of the device that is the source of the alarm at the FACP and the annunciator(s).
    c) Operation of audible and visible notification devices throughout the building until silenced at FACP.
    d) Closing doors normally held open by magnetic door holders.
    e) Unlocking designated doors.
    f) Shutting down supply and return fans serving zone where alarm is initiated.
    g) Closing smoke dampers on system serving zone where alarm is initiated.
    h) Initiation of smoke control sequence through the building temperature control system.
    i) Notifying the local fire department.

6. Supervisory Operations: Upon activation of a supervisory device such as fire pump power failure, low air pressure switch, and tamper switch, the system shall operate as follows:

    a) Activate the system supervisory service audible signal and illuminate the LED at the control unit and the graphic annunciator.
    b) Pressing the Supervisory Acknowledge Key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
    c) Record the event in the FACP historical log.
    d) Transmission of supervisory signal to remote central station.

7. Restoring the condition shall cause the Supervisory LED restore system to normal.
8. Alarm Silencing: If the “Alarm Silence” button is pressed, all audible alarm signals shall cease operation.
9. System Reset

    a) The “System Reset” button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps (“IN PROGRESS”, “RESET COMPLETED”) as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate “ALARM PRESENT, SYSTEM RESET ABORTED.”
    b) Should an alarm condition continue, the system will remain in an alarmed state.

10. Drill: A manual evacuation (drill) switch shall be provided to operate the notification appliances without causing other control circuits to be activated.
11. WALKTEST: The system shall have the capacity of one (1) programmable passcode protected one person testing group. The actuation of the “enable one person test” program at the control unit shall activate the “One Person Testing” mode of the system as follows:

    a) The city circuit connection shall be bypassed for the testing group.

b) Control relay functions associated to the testing group shall be bypassed.
c) The control unit shall indicate a trouble condition.
d) The alarm activation of any initiation device in the testing group shall cause the audible notification appliances to sound a code to identify the device.
e) The unit shall automatically reset itself after signaling is complete.
f) Any momentary opening of an initiating or notification appliance circuit wiring shall cause the audible signals to sound for 4 seconds indicating the trouble condition.

F. Analog Smoke Sensors:

1. Monitoring: FACP shall individually monitor sensors for calibration, sensitivity, and alarm condition, and shall individually adjust for sensitivity. The control unit shall determine the condition of each sensor by comparing the sensor value to the stored values.
2. Environmental Compensation: The FACP shall maintain a moving average of the sensor's smoke chamber value to automatically compensate for dust, dirt, and other conditions that could affect detection operations.
3. Programmable Sensitivity: Photoelectric Smoke Sensors shall have 7 sensitivity levels ranging from 0.2% to 3.7%, programmed and monitored from the FACP.
4. Sensitivity Testing Reports: The FACP shall provide sensor reports that meet NFPA 72 calibrated test method requirements. The reports shall be viewed on a CRT Display or printed for annual recording and logging of the calibration maintenance schedule.
5. The FACP shall automatically indicate when an individual sensor needs cleaning. The system shall provide a means to indicate that a sensor requires cleaning. When a sensor's average value reaches a predetermined value, (3) progressive levels of reporting are provided. The first level shall indicate that a sensor is close to a trouble reporting condition and will be indicated on the FACP as "ALMOST DIRTY." This condition provides a means to alert maintenance staff of a dirty sensor without creating a trouble in the system. If this indicator is ignored, a second level "DIRTY SENSOR" condition shall be indicated at the FACP and subsequently a system trouble is reported to the Central Monitoring Station. The sensor base LED shall glow steady giving a visible indication at the sensor location. The "DIRTY SENSOR" condition shall not affect the sensitivity level required to alarm the sensor. If a "DIRTY SENSOR" is left unattended, and its average value increases to a third predetermined value, an "EXCESSIVELY DIRTY SENSOR" trouble condition shall be indicated at the control unit.
6. The FACP shall continuously perform an automatic self-test on each sensor which will check sensor electronics and ensure the accuracy of the values being transmitted. Any sensor that fails this test shall indicate a "SELF TEST ABNORMAL" trouble condition.

G. Fire Suppression Monitoring:

1. Water flow: Activation of a water flow switch shall initiate general alarm operations.
2. Sprinkler valve tamper switch: The activation of any valve tamper switch shall activate system supervisory operations.

H. Audible Alarm Notification: By horns in areas as indicated on drawings.

I. Power Requirements

1. The control unit shall receive 120 VAC power via a dedicated circuit.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal 120 VAC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control unit.
4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control unit. A green "power on" LED shall be displayed continuously while incoming power is present.
5. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be indicated at the control unit.
6. The system shall support 100% of addressable devices in alarm or operated at the same time, under both primary(AC) and secondary (battery) power conditions.
7. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.5. SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
2. Wiring diagrams from manufacturer.
3. Shop drawings showing system details including location of FACP, all devices, circuiting and details of graphic annunciator.
4. System Power and battery charts with performance graphs and voltage drop calculations to assure that the system will operate per the prescribed backup time periods and under all voltage conditions per UL and NFPA standards.
5. System operation description including method of operation and supervision of each type of circuit and sequence of operations for all manually and automatically initiated system inputs and outputs. A list of all input and output points in the system shall be provided with a label indicating location or use of SLC, NAC, relay, Sensor and auxiliary control circuits.
6. Operating instructions for FACP.
7. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.
8. Product certification signed by the manufacturer of the fire alarm system components certifying that their products comply with indicated requirements.

9. Record of field tests of system.

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions if required to make clarifications or revisions to obtain approval.

C. LEED Submittal:

1. Product Data for Credit MR 4.1 (and Credit MR 4.2): For products having recycled content, required documentation for LEED submittal indicating percentages by weight of postconsumer and pre-consumer recycled content. Include statement indicating costs for each product having recycled content. See specification 018113.
2. Product data for Credit MR 5.1 (and Credit MR 5.2): For product manufactured, assembled, or extracted within 500 miles of project site, documentation as required for LEED submittal. Include statement indicating costs for each product that is regional. See specification 018113.

1.6. QUALITY ASSURANCE

A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

B. Each and all items of the Fire Alarm System shall be listed as a product of a single fire alarm system manufacturer under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.7. EXTRA MATERIALS

A. General: Furnish extra materials, packaged with protective covering for storage, and identified with labels clearly describing contents as follows:

1. Break Rods for Manual Stations: Furnish quantity equal to 15 percent of the number of manual stations installed; minimum of 6 rods.
2. Pluggable LED’s for Remote Indicating Panels: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
3. Strobe Units: Furnish quantity equal to 10 percent of the number of units installed, but not less than one.
4. Smoke Sensors, Fire Detectors, and Flame Detectors: Furnish quantity equal to 10 percent of the number of units of each type installed but not less than one of each type.
5. Sensor Bases: Furnish quantity equal to 2 percent of the number of units of each type installed but not less than one of each type.
6. Printer Ribbons: Furnish 6 spare printer ribbons.

PART 2 -PRODUCTS

2.1. FIRE ALARM CONTROL PANEL (FACP)

A. General: Comply with UL 864, "Control Units for Fire-Protective Signaling Systems."

B. The following FACP hardware shall be provided:

1. Power Limited base panel with red cabinet and door, 120 VAC input power.
2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node.
4. 2,000 points of annunciation where one (1) point of annunciation equals:

    a) 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
    b) 1 LED on panel or 1 switch on panel.

5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.
6. Municipal City Circuit Connection with Disconnect switch, 24VDC Remote Station (reverse polarity), local energy, shunt master box, or a form “C” contact output.
7. One auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
8. One auxiliary relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
9. Three (3) Class B or A (Style Y/Z) Notification Appliance Circuits (NAC; rated 3A @ 24VDC, resistive).
10. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
11. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
12. Four (4) form “C” Auxiliary Relay Circuits (Form C contacts rated 2A @ 24 VDC, resistive), operation is programmable for trouble, alarm, supervisory of the other fire response functions. Relays shall be capable of switching up ½ A @ 120VAC, inductive.
13. The FACP shall support up to (5) RS-232-C ports and one service port. All (5) RS-232 Ports shall be capable of two –way communications.
14. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
15. Programmable DACT for either Common Event Reporting or per Point Reporting.
16. Service Port Modem for dial in passcode access to all fire control panel information.

C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

E. Simplex Model No. 4100-9801, or approved equal.

2.2. ADDRESSABLE MANUAL PULL STATIONS

A. Description: Addressable double-action type, red LEXAN or metal, and finished in red with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

B. Simplex Model No. 4099-9003, or approved equal.

2.3. SMOKE SENSORS AND BASE

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Sensors do not require resetting or readjustment after actuation to restore normal operation.
4. Plug-In Arrangement: Sensor and associated electronic components are mounted in a module that connects to a fixed base with a twist-locking plug connection. Base shall provide break-off plastic tab that can be removed to engage the head/base locking mechanism. No special tools shall be required to remove head once it has been locked. Removal of the sensor head shall interrupt the supervisory circuit of the fire alarm detection loop and cause a trouble signal at the control unit.
5. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
6. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
7. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a “wrong device”, the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a “Wrong Device” trouble condition.
8. The sensor's electronics shall be immune from false alarms caused by EMI and RFI.
9. Addressability: Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
10. Removal of the sensor head for cleaning shall not require the setting of addresses.

B. Type: Smoke sensors shall be of the photoelectric type. Where acceptable per

manufacturer specifications, ionization type sensors may be used.

C. Simplex Sensors Model No. 4098-9714 with base Model No. 4048-9792, approved equal.

D. Duct Smoke Sensor Model 4098-9756: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

1. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable.
2. Duct Housing shall provide a relay control trouble indicator Yellow LED.
3. Compact Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
4. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
5. Duct Housing shall provide a magnetic test area and Red sensor status LED.
6. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
7. Each duct sensor shall have a Remote Test Station Model 2098-9806 with an alarm LED and test switch.

2.4. HEAT SENSORS AND BASE

A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.

B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

E. Simplex Model No. 4098-9733 with base Model No. 4098-9792, or approved equal.

2.5. ALARM-NOTIFICATION APPLIANCES MODEL 4906 SERIES

A. Speaker/Visible: Combination Speaker/Visible (S/V) units combine the speaker and visible functions into a common housing. The S/V shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation, while the speaker operates on

a 25VRMS or 70.7VRMS NAC.

1. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC and UTP conductors, having a minimum of 3 twists per foot is required for addressable strobe connections.
2. The following taps are available: 0.25W, 0.05W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
3. The S/V shall have a frequency response of 400 to 4000 hz for Fire Alarm and 125 to 12kHz for general signaling.
4. The S/V installs directly to a 4" square, 1 ½ inch deep electrical box with 1 ½ inch extension.

B. Synchronization Control Module (SCM) provides synchronization of strobes at a rate of 1Hz and operates horns with aTemporal Code Pattern operation. The Module shall provide the capability to silence the audible signals, while the strobes continue to flash, over a single pair of wires. The capability to synchronize multiple notification appliance circuits shall be provided.

2.6. ADDRESSABLE CIRCUIT INTERFACE MODULES

A. Addressable Circuit Interface Modules: Arrange to monitor one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of waterflow, valve tamper, non-addressable devices, and for control of evacuation indicating appliances and AHU systems.

B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line or a separate two wire pair running from an appropriate power supply as required.

C. There shall be two types of modules:

1. Type 1: Monitor Circuit Interface Module:

   a) For conventional 2-wire smoke detector and/or contact device monitoring with Class B or Class A wiring supervision. This module shall communicate status (normal, open circuit, short circuit and current limited conditions) to the FACP.

2. Type 2: Line Powered Control Circuit Interface Module

   a) This type of module will provide non-supervised form C relay switching with a single "Form C" contact rated at 2 A @ 24 VDC resistive, power limited and at 1/2 A @ 120 VAC resistive, non-power limited. Both power and communications to this module shall be supplied by the two wire multiplexing signaling line circuit. The system shall be capable of energizing 100% of the relays connected to the signaling line circuit.

D. The Circuit Interface Module shall be supervised and uniquely identified by the control

unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

E. Simplex Model No 4090, or approved equal.

2.7. MAGNETIC DOOR HOLDERS

A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, 24VAC, 24VDC source, and develops a minimum of 25 lbs. holding force.

B. Material and Finish: Match door hardware.

C. Simplex Model No 2088 – 9608, or approved equal.

2.8. REMOTE LCD ANNUNCIATOR

A. Provide 1 Remote LCD Annunciator with the same "look and feel" as the FACP operator interface. The Remote LCD Annunciator shall use the same Primary Acknowledge, Silence, and Reset Keys, Status LEDs and LCD Display as the FACP.

B. Annunciator shall have super-twist LCD display with two lines of 40 characters each. Annunciator shall be provided with three (3) programmable LEDs (two selectable as red or yellow; one selectable as green or yellow).

C. Under normal conditions the LCD shall display a "SYSTEM IS NORMAL" message and the current time and date.

D. Should an abnormal condition be detected the appropriate LED (Alarm, Supervisory or Trouble) shall flash. The unit audible signal shall pulse for alarm conditions and sound steady for trouble and supervisory conditions.

E. The LCD shall display the following information relative to the abnormal condition of a point in the system:

1. 40 character custom location label.
2. Type of device (e.g., smoke, pull station, waterflow).
3. Point status (e.g., alarm, trouble).

F. Operator keys shall be key switch enabled to prevent unauthorized use. The key shall only be removable in the disabled position. Acknowledge, Silence and Reset operation shall be the same as the FACP.

G. Simplex Model No. 4606-9101, or approved equal.

2.9. GRAPHIC ANNUNCIATOR

A. Annunciator Unit (zoned system): Provide an LED-indicating light located on the floor plan for each zone. Mark zone boundaries on the annunciator floor plan.

B. Annunciator Unit (addressable system): Provide an LED-indicating light located on the floor plan for each device indicating the type of device and floor on which a signal was actuated.

C. Provide individual LED indicators for each alarm and supervisory device zone and a LED to indicate system trouble. Additional LEDs indicate normal power and emergency power modes for the system. A toggle or push-button switch tests the LEDs mounted on the unit. The test switch does not require key operation.

D. Enclosure: Beige finish to match Fire Alarm Control Units. The locking cover/display assembly is hinged on the left. Key and lock shall be common to all secured fire alarm system enclosures.

E. Simplex Model No. OPGASS, or approved equal.

2.10. EMERGENCY POWER SUPPLY

A. General: Components include battery and charger.

B. Battery: Sealed lead-acid type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all alarm indicating devices in alarm or supervisory mode for a period of 5 minutes

2.11. FIRE GONG

A. Fire Alarm

1. 24 VDC fire alarm bell provided as an option under Division 21 Section “Water Based Fire Suppression System – Sprinklers”.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer’s recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), annunciator(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

B. Existing Fire Alarm Equipment: Shall be maintained fully operational until the new equipment has been tested and accepted.

C. Water-Flow and Valve Supervisory Switches: Connect for each sprinkler valve required to be supervised.

D. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

3.3 WIRING INSTALLATION

A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (AH J) and shall be installed in accordance with the appropriate articles from the current approved edition of NFPA 70: National Electric Code (NEC).

B. Contractor shall obtain from the Fire Alarm System Manufacturer written instruction regarding the appropriate wire/cable to be used for this installation. No deviation from the written instruction shall be made by the Contractor without the prior written approval of the Fire Alarm System Manufacturer.

C. Color Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color code for alarm initiating device circuits wiring and a different color code for supervisory circuits. Color-code notification appliance circuits differently from alarm-initiating circuits. Paint fire alarm system junction boxes and covers red.

D. Risers: Install at least 2 vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other, in accordance with NFPA 72, with a minimum 2-hour rated cable assembly 2-hour rated shaft or enclosure 2-hour rated stairwell in a fully sprinklered building, so the loss of one riser does not prevent the receipt or transmission

of signal from other floors or zones.

E. Wiring to Central Station Transmitter: 1-inch conduit between the FACP and the central station transmitter connection as indicated. Install number of conductors and electrical supervision for connecting wiring as required to suit central-station monitoring function. Final connections to terminals in central station transmitter are made under another contract.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

D. Final Test Notice: Provide a 10-day minimum notice in writing when the system is ready for final acceptance testing.

E. Minimum System Tests: Test the system according to the procedures outlined in NFPA 72.

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log.

H. Final Test, Certificate of Completion, and Certificate of Occupancy:

1. Test the system as required by the Authority Having Jurisdiction (AH J) in order to obtain a certificate of occupancy.

3.5 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Clean unit internally using methods and materials recommended by manufacturer.

B. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels and adjusting controls and sensitivities to suit actual occupied conditions. Provide up to three visits to the site for this purpose.

3.6 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of 8 hours' training.
2. Schedule training with the Owner at least seven days in advance.

END OF SECTION

SECTION 323100 – DECORATIVE FENCES AND GATES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions.

B. This project is to be LEED certified. Refer to Division 1 Sections, including "LEED Requirements", "Construction Waste Managements" and "Commissioning Requirements" for mandatory work which may apply to all contractors, installers and suppliers.

1.2 SUMMARY

A. This Section includes the following:

1 Fencing system complete with all hardware, posts, rails, gates, and accessories necessary for a structurally integrated and aesthetically balanced installation.
2. Swinging gates and related hardware
3. Concrete foundation for posts

1.3 REFERENCES

A. American Society for Testing and Materials:

1. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
2. ASTM A653 Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
4. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
5. ASTM C33 Standard Specification for Concrete Aggregates
6. ASTM C150 Standard Specification for Portland Cement
7. ASTM C207 Standard Specification for Hydrated Lime for Masonry Purposes
8. ASTM D1654 Standard Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments
9. ASTM D2248 Standard Practice for Detergent Resistance of Organic Finishes
10. ASTM D2794 Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation
11. ASTM D3359 Standard Test Methods for Measuring Adhesion by Tape Test
12. ASTM D3363 Standard Test Method for Film Hardness by Pencil Test
13. ASTM D4141 Standard Practice for Conducting Black Box and Solar Concentrating Exposures of Coatings
14. ASTM F2408 Standard Specification for Ornamental Fences Employing Galvanized Steel Tubular Pickets

B. American Concrete Institute:

1. ACI 301 Specifications for Structural Concrete

1.4 SYSTEM DESCRIPTION

A. The Manufacturer shall supply a Fencing System complete with all hardware, posts, rails, gates and accessories necessary for a complete and aesthetically balanced installation.
B. Design Requirements: Fencing system, foundation and installation shall be engineered to withstand [90] mph wind load. (or IBC 2006, which ever is more stringent.)

1.5 SUBMITTALS

A. Product Data: For each product indicated, include manufacturer's recommendations for installation.
B. Installation Drawings: Show layout, locations, components, materials, dimensions, sizes, weights, finishes of components, installation and operational clearances, gate swings, post sizes, spacing and mesh type, gate details/dimensions, details of post anchorage, and post attachment/bracing.
C. Samples: Provide color selections and samples for finishes on fence and accessories if requested by the specifier.

1.6 QUALITY ASSURANCE

A. The contractor shall provide laborers and supervisors who are thoroughly familiar with the type of construction involved and the materials and techniques specified. Review and follow manufacturer's installation instructions.
B. Provide fence system and gates, as a complete unit produced by a single manufacturer, including necessary erection accessories, fittings and fastenings.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with a minimum of 5 years documented experience.
D. Field Quality Control to be conducted by Owner's Project Manager.

1.7 DELIVERY, HANDLING, AND STORAGE

A. Deliver fence materials, gates, posts, and accessories to project site, completely pre-finished. Upon receipt at the job site, all materials shall be checked to ensure that no damages occurred during shipping. Materials shall be handled and stored properly to protect against damage and theft.
B. Handle fence components to protect finish coating from any scuffs, abrasion or other damage during unloading and installation. Excessive damage to factory applied coatings will be cause for rejection.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers:

1. Basis-of-Design: Betafence USA, Ennis, TX 75119, fax: 972-878-4703, 888-650-4766, or approved equivalent.

2.2 MATERIAL

A. Fencing System : The UpGrade-C Ornamental Fence System shall conform to Betafence USA's Defender 2-Rail style manufactured by Betafence USA. Subject to the performance and design requirement specified herein, fence and gates shall be manufactured from the following materials and be made of 95% recycled content:

1. Steel Posts and Pickets: To be per ASTM F 2408 with increased strength to a minimum yield of 50,000 psi. Coating shall be per Section 5.1.1, having a triple O.D. coating of zinc, a conversion coating and clear inorganic coating.
2. Formed Channel Rails: To be per ASTM A 653 – CS Type B, galvanized coating to be G90.
3. Fence Panels
   a. Panel Width: Standard Panel width shall be 8' wide.
   b. Panel Height: Panel Height shall be UpGrade-C 5' High.

B. Pickets: Pickets to be 3/4" square tubing with 18 gauge wall thickness spaced UpGrade-C 4-19/32" OC with 3/4" ST on center.

C. Rails: Rails shall be 1 1/2" formed channel with 15 gauge wall thickness.

D. Posts: Posts shall be 2" square tubing with 14 gauge wall thickness.

1. Post Caps: Shall be of press on type steel caps zinc plated to ASTM B633, Service class II or malleable steel caps galvanized to ASTM A123.
2. Panel Hangers: Shall be stainless or galvanized steel with galvanized, stainless, or zinc plated fasteners. All brackets shall be finished to match fence finish and color.
3. Picket Finials: Picket finials are cast alloy Types 1 (Round Point), welded to picket and are finished to match fence color.

E. Gate Kits: Design of gates shall be as shown on the drawings.

1. Gate Uprights and Panels: Materials as described above in 2.2.
2. Frame Uprights: Shall be factory MIG welded, then assembled in the field. If necessary, truss rods, or cables to be used to prevent gate sag and allow for future adjustment.
3. Gate Posts and Foundation: Size as determined by Engineer, based on gate size, local wind loading requirements, and installation type.

F. Swing Gates: Design of gates shall be as shown on the drawings.

1 Gate Frames and Infill Panels: Materials as described above in 2.2.
2 Frame Members: Shall be MIG welded. If necessary, truss rods or cables to be used to prevent gate sag and allow for future adjustment.
3 Gate Posts and Foundation: Size as determined by Engineer, based on gate size, local wind loading requirements, and installation type.

4 Hinges: Manufacturer's standard hinges, structurally capable of supporting gate leaf and allow opening and closing without binding. Non-lift-off type hinge design shall permit gate to swing 180□ (degrees). Hinge pins shall be non-removable.
5 Latch: Capable of retaining gate in closed position and have provision for padlock.
6 Keeper: Provide keeper for each gate leaf over 5 feet wide. Gate keeper shall consist of mechanical device for securing free end of gate when in full open position.
7. Panic Hardware: Provide manufacturer's panic hardware as indicated on drawing.

2.3 POWDER COATED FACTORY FINISH

A. Coating Material: Posts, post caps, rails, brackets, joint extrusions and security mesh shall be finished with a factory applied TGIC polyester powder coating of the "Super-Durable" class. Powder coated finish shall meet or exceed the following performance criteria.

B. Applicable Requirements to Validate the Coating Process:

1. Adhesion Resistance: ASTM D3359, Measuring Adhesion by Tape Test, Method B.
   a. Minimum Performance Requirement: Coating retention of not less than 95%.
2. Impact Resistance: ASTM D2794, Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   a. Minimum Performance Requirement: resistance to impact not less than 120 in. /lb.
3. Film Hardness ASTM D3363, Film Hardness by Pencil Test
   a. Minimum Performance Requirement – Minimum Hardness: 2H.
4. Solar Concentration Exposure: ASTM D4141, Conducting Black Box and Solar Concentrating Exposures of Coatings, Method C. (Equivalent to EMMAQUA NTW)
   a. Minimum Performance Requirement - coating must test to a minimum of 50% Gloss Retention at 1,400 MJ/m2 with no film failure, chalking, cracking or checking and no more than 10% fading.
5. Thickness: Provide film thickness of 2-4 mils as measured by manufacturer's standard powder coat measurement and inspection procedures.
6. Pretreatment: The fence sheeting and framework shall be prepared using a pre-treatment cleaning system to remove foreign material and to properly prepare the surface to achieve the coating system requirements specified above.
7. Curing: Heat cure in accordance with powder manufacturer's prescribed cure schedule to properly crosslink and bond finish to metal substrate.
8. Chemical Resistance:
   a. Muriatic Acid Resistance (15 minute spot test)
      1) Procedure: Apply 10 drops of 10% (by volume) solution of muriatic acid (37% commercial grade hydrochloric acid) in tap water on the coated surface and cover it with a watch glass, convex side up. The acid solution and test shall be conducted a 18° to 27°C (65° to 80°F). After a 15 minute exposure, wash off with running tap water.
         a) Performance: No blistering and no visual change in appearance when examined by the unaided eye.
   b. Mortar Resistance (24 hour pat test)
      1) Procedure: Prepare mortar by mixing 75g (2.6 oz) of building lime (conforming to ASTM C207) and 225g (7.9 oz) of dry sand, both passing through a 10-mesh wire screen with sufficient water, approximately 100g (3.5 oz), to make a soft paste. Immediately apply wet pats mortar about 1300 mm² (2 in²) in area and 12 mm (1/2 in) in thickness to coated specimens, which have been aged at least 24 hours after coating. Immediately expose test specimens for 24 hours to 100% relative humidity at 38°C (100°F).

a) Performance: Mortar shall dislodge easily from the coated surface, and any residue shall be removable with a damp cloth. Any lime residue should be easily removed with the 10% muriatic acid solution. There shall be no loss of film adhesion or visual change in the appearance when examined by the unaided eye. Note: A slight staining or discoloration may be apparent on orange, yellow or metallic coatings. This should be discussed with the specifying source prior to selection of color.

c. Detergent Resistance
   1) Procedure: Prepare a 3% (by weight) solution of detergent as prescribed in ASTM D2248, and distilled water. Immerse at least two test specimens in the detergent solution at 38°C (100°) for 72 hours. Remove and wipe the specimens dry. Immediately apply tape (Permacel 99 or equivalent) 20 mm (3/4 in) wide by pressing down firmly against the coating to eliminate voids and air pockets. Place the tape longitudinally along the entire length of the test specimens. If blisters are visible, then the blistered area must be taped and rated. Sharply pull off at a right angle to the plane of the surface being tested, per ASTM D3359.
      a) Performance: No loss of adhesion of the film to the metal. No blistering and no significant visual change in the appearance when examined by the unaided eye.

d. Corrosion Resistance:
   1) Procedure: Preparation of Test Specimens- Perform a single scribe the length of the specimen, within one inches of any edge and deep enough to expose the base metal. Expose the specimen for 1,000 hours according to ASTM B117-07 using a 5% salt solution and 95°F operational temperature. After exposure, remove specimens and wipe dry. Immediately apply tape (Permacel 99 or equal) over scribed are by pressing down firmly against the coating. Sharply pull the tape off at a right angle to the surface being tested.
      a) Performance: The required is a minimum of seven on the scribed edge and minimum blister rating of eight within the test specimen field in accordance with tables in ASTM D1654.

2.4 CONCRETE FOOTINGS

This section shall be superseded by requirements of anti-ram barrier system if used in conjunction with this installation

A. General: Comply with ACI 301 for cast-in-place concrete; materials consisting of Portland cement complying with ASTM C150, aggregates complying with ASTM C33, and potable water.
B. Concrete Mixes: Normal-weight concrete air entrained with not less than 3000-psi (20.7-MPa) compressive strength (28 days), 3-inch (75-mm) slump, and 1-inch (25-mm) maximum size aggregate.
C. Footings: Footings shall be minimum 3,000 psi after twenty-eight (28) days concrete. Footing sizes shall be determined by Engineer.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify areas to receive fencing.
B. Coordinate fence installation with work of other sections listed in these specifications.

C. Examine conditions under which fencing and gates are to be installed. Notify Contractor of unsatisfactory conditions. Do not proceed with work until conditions are satisfactory to the installer.

3.2 INSTALLATION

A. Install fence and gates in accordance with manufacturer's instructions and approved installation drawings. Install fencing to withstand wind load as specified.
B. Handle fence components to protect finish coating from any scuffs, abrasion or other damage during installation. Excessive damage to factory applied coatings will be cause for rejection.
C. Space posts at dimensions indicated in the installation drawings. Attach fence rails to posts using galvanized, stainless steel or zinc plated panel hanger brackets supplied by manufacturer. Field welding of panels to posts is unacceptable as it will cause significant damage to the galvanizing and powder coat protective finishes.
D. Concrete Footings: Place concrete around posts and vibrate or tamp for consolidation. Verify that posts are set plumb, aligned, and at correct height and spacing, and stabilized in position during placement and finishing operations until concrete is sufficiently cured. Protect portion of posts above ground from concrete splatter.
E. Install gates level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust gate to operate smoothly, easily, and quietly throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
F. Avoid unnecessary cutting, drilling and welding of pre-finished fence components. If necessary to cut drill, weld or otherwise modify product due to field conditions, repair factory finish in accordance with item 2.3.7 below.
G. Touch-up any necessary areas by lightly sanding; clean area thoroughly, apply a zinc-rich cold galvanizing primer followed by a high quality acrylic lacquer paint to match finish. (Touch-up paint available from manufacturer) Note: field applied touch-up cannot match the performance of factory applied finishes and should be limited in use.

3.3 CLEANING

A. Fence contractor shall remove packing materials and unused product and level uneven areas due to excavations created by fence installations.

END OF SECTION 323100