PROJECT MANUAL
For
SECURE ENTRANCES FOR MULTIPLE SITES
(Conowingo ES / Rising Sun ES)

SECURE ENTRANCES PROJECT
VOLUME 2 OF 2

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B. Legal disposal of demolished items.

1.02 RELATED REQUIREMENTS
A. Section 01 10 00 - Summary: Limitations on Contractor's use of site and premises.
B. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
C. Section 01 60 00 - Product Requirements: Handling and storage of items removed for salvage and relocation.

1.03 REFERENCE STANDARDS
A. 29 CFR 1926 - Safety and Health Regulations for Construction.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 33 00 - Submittal Procedures.
C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 QUALITY ASSURANCE
A. Demolition Firm Qualifications: Company specializing in the type of work required.
   1. Minimum of five years of documented experience.

1.06 PROJECT CONDITIONS
A. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.

PART 2 PRODUCTS -- NOT USED

PART 3 EXECUTION

3.01 SCOPE
A. As indicated on Drawings and herein specified.
B. Fill excavations, open pits, and holes in ground areas generated as result of removals, using specified fill; compact fill as required so that required rough grade elevations do not subside within one year after completion.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS
A. Comply with other requirements specified in Section 01 70 00 Execution and Closeout Requirements.
B. Comply with applicable codes and regulations for demolition operations and safety of the public.
   1. Obtain required permits.
   2. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
3. Provide, erect, and maintain temporary dust proof partitions/wall assembly barriers and security devices.
4. Use adequate physical barriers and wall assemblies to prevent access to areas that could be hazardous to workers or the public.
5. Conduct operations to minimize effects on and interference with adjacent construction and occupants.
6. Do not close or obstruct means of egress corridors, roadways or sidewalks without permit.
7. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.

C. Do not begin removal until receipt of notification to proceed from Owner.

D. Do not begin removal until built elements to be salvaged or relocated have been removed.

E. Protect existing structures and other elements that are not to be removed.
   1. Provide bracing and shoring.
   2. Prevent movement or settlement of adjacent structures.
   3. Stop work immediately if adjacent structures appear to be in danger.

F. If hazardous materials are discovered during removal operations, stop work and notify Architect and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.

3.03 EXISTING UTILITIES

A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.

B. Protect existing utilities to remain from damage.

C. Do not close, shut off, or disrupt existing life safety systems that are in use without permission from the Owner.

D. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without permission from the Owner.

E. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary. Call "Miss Utility" at least 48 hours prior to starting work.

F. Remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.

G. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
   1. Verify that construction and utility arrangements are as shown.
   2. Report discrepancies to Architect before disturbing existing installation.
   3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.

B. Separate areas in which demolition is being conducted from other areas that are still occupied.
   1. Provide, erect, and maintain temporary dustproof partitions and wall assemblies during demolition and construction.
C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.

D. Remove existing work as indicated and as required to accomplish new work.
   1. At areas of demolition and transition, remove materials and finishes including, but not limited to, rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on drawings and notes.

E. Services (Including but not limited to HVAC, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
   1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
   2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
   3. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings; remove back to source of supply where possible, otherwise cap stub and tag with identification.

F. Protect existing work to remain.
   1. Prevent movement of structure; provide shoring and bracing if necessary.
   2. Perform cutting to accomplish removal neatly and as specified for cutting new work.
   3. Repair adjacent construction and finishes damaged during removal work.
   4. Patch as specified for patching new work.
   5. Patch to match existing at areas of transition and demolition unless noted and/or scheduled otherwise.

3.05 EXISTING UNDERGROUND UTILITY DEMOLITION
   A. Excavate and expose existing underground utilities and related structures designated for, or as required to implement, removals. For excavation operations refer to Section 31 20 00 - Excavating, Filling and Grading. Remove existing utility structure castings. Backfill excavations, upon completion of utility demolition operations. For backfill operations refer to Section 31 20 00 - Excavation, Filling and Grading.

3.06 EXISTING SITE IMPROVEMENTS DEMOLITION
   A. Existing Subsurface Conditions: Verify existing pavement materials and respective thicknesses during pre-bid inspection. Obtain written authorization from the Owner before conducting test hole explorations of existing pavements within the project site. Conditions existing during prebid inspections will not be altered or modified.
   B. Existing Pavements: Demolish existing pavements to limits indicated. Neatly cut existing bituminous concrete pavement to straight, smooth and sharp edges perpendicular to pavement surface.
   C. Existing Walks: Demolish existing walks to the nearest joint to limits indicated on the contract documents.
   D. Existing Curbing: Demolish existing curbing to the nearest joint to limits indicated on the contract documents.
   E. Miscellaneous: Demolish additional miscellaneous existing site improvements indicated, specified and required to construct project.

3.07 DEBRIS AND WASTE REMOVAL
   A. Remove debris, junk, and trash from site.
B. Remove from site all materials not to be reused on site; comply with requirements of Section 01 74 19 - Waste Management.
C. Leave site in clean condition, ready for subsequent work.
D. Clean up spillage and wind-blown debris from public and private lands.
E. See Section 01 74 19 Construction Waste Management and Disposal.

END OF SECTION
SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Formwork for cast-in-place concrete, with shoring, bracing and anchorage.
B. Openings for other work.
C. Form accessories.
D. Form stripping.

1.02 RELATED REQUIREMENTS
A. Section 03 20 00 - Concrete Reinforcing.
B. Section 03 30 00 - Cast-in-Place Concrete.
C. See Structural Drawings A-100 for additional Project Specifications.

1.03 REFERENCE STANDARDS
A. See Structural Drawings A-100 for Reference Standards.

1.04 SUBMITTALS
A. See Section 01 33 00 - Submittal Procedures.
B. See Structural Drawings A-100 for additional Submittal Requirements.

1.05 QUALITY ASSURANCE
A. Perform work of this section in accordance with ACI 347, ACI 301, and ACI 318.
B. Refer to Structural Drawings A-100 for additional Quality Assurance requirements and Inspection requirements.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver prefabricated forms and installation instructions in manufacturer's packaging.
B. Store prefabricated forms off ground in ventilated and protected manner to prevent deterioration from moisture.

PART 2 PRODUCTS

2.01 GENERAL
A. See Structural Drawings A-100 for additional product requirements.

2.02 FORMWORK - GENERAL
A. Provide concrete forms, accessories, shoring, and bracing as required to accomplish cast-in-place concrete work.
B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
C. Comply with applicable State and local codes with respect to design, fabrication, erection, and removal of formwork.

2.03 WOOD FORM MATERIALS
A. Softwood Plywood: PS 1, B-B High Density Concrete Form Overlay, Class I.
B. Lumber: HEM-FIR species; #2 grade; with grade stamp clearly visible.
2.04 REMOVABLE PREFABRICATED FORMS  
   A. Preformed Steel Forms: Minimum 16 gage matched, tight fitting, stiffened to support weight of concrete without deflection detrimental to tolerances and appearance of finished surfaces.

2.05 FORMWORK ACCESSORIES  
   A. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.  
   B. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.

PART 3 EXECUTION

3.01 GENERAL  
   A. See Structural Drawings A-100 for additional execution requirements.

3.02 EXAMINATION  
   A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.03 ERECTION - FORMWORK  
   A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.  
   B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.  
   C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.  
   D. Align joints and make watertight. Keep form joints to a minimum.  
   E. Obtain approval before framing openings in structural members that are not indicated on drawings.  
   F. Provide fillet strips on external corners of beams, joists, and columns.  
   G. Install void forms in accordance with manufacturer's recommendations. Protect forms from moisture or crushing.  
   H. Coordinate this section with other sections of work that require attachment of components to formwork.  
   I. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Architect before proceeding.

3.04 APPLICATION - FORM RELEASE AGENT  
   A. Apply form release agent on formwork in accordance with manufacturer's recommendations.  
   B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS  
   A. Provide formed openings where required for items to be embedded in passing through concrete work.  
   B. Locate and set in place items that will be cast directly into concrete.  
   C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.  
   D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.

F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FIELD QUALITY CONTROL
A. Do not reuse wood formwork more than 2 times for concrete surfaces to be exposed to view. Do not patch formwork.

3.07 FORM REMOVAL
A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
B. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
C. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

END OF SECTION
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SECTION 03 20 00
CONCRETE REINFORCING

PART 1  GENERAL
1.01  SECTION INCLUDES
   A.  Reinforcing steel for cast-in-place concrete.
   B.  Supports and accessories for steel reinforcement.

1.02  RELATED REQUIREMENTS
   A.  Section 03 10 00 - Concrete Forming and Accessories.
   B.  Section 03 30 00 - Cast-in-Place Concrete.
   C.  See Structural Drawings A-100 for additional Project Specifications.

1.03  REFERENCE STANDARDS
   A.  See Structural Drawings A-100 for Reference Standards.

1.04  SUBMITTALS
   A.  See Section 01 33 00 - Submittal Procedures.
   B.  Shop Drawings:  Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices.
      1.  Prepare shop drawings under supervision of a Professional Structural Engineer experienced in design of work of this type and licensed in the State in which the Project is located.
   C.  Manufacturer's Certificate:  Certify that reinforcing steel and accessories, products supplied for this project meet or exceed specified requirements.
   D.  See Structural Drawings A-100 for additional Submittal Requirements.

1.05  QUALITY ASSURANCE
   A.  Perform work of this section in accordance with ACI 301.
      1.  Maintain one copy of each document on project site.
   B.  Provide Architect with access to fabrication plant to facilitate inspection of reinforcement. Provide notification of commencement and duration of shop fabrication in sufficient time to allow inspection.
   C.  Refer to Structural Drawings for additional Quality Assurance requirements and Inspection requirements.

PART 2  PRODUCTS
2.01  GENERAL
   A.  See Structural Drawings A-100 for additional product requirements.

2.02  REINFORCEMENT
   A.  Reinforcing Steel:  ASTM A615/A615M, Grade 60 (60,000 psi).
      1.  Plain billet-steel bars.
      2.  Unfinished.
      3.  Galvanized in accordance with ASTM A767/A767M, Class I.
      4.  Epoxy coated in accordance with ASTM A775/A775M.
   B.  Reinforcing Steel:  ASTM A706/A706M, deformed low-alloy steel bars.
      1.  Unfinished.
      2.  Galvanized in accordance with ASTM A767/A767M, Class I.
      3.  Epoxy coated in accordance with ASTM A775/A775M.
C. Steel Welded Wire Reinforcement: Galvanized ASTM A 185/A 185M, plain type.
   1. Flat Sheets.

D. Reinforcement Accessories:
   1. Tie Wire: Annealed, minimum 16 gage.
   2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of
      reinforcement during concrete placement.
   3. Provide galvanized components for placement within 1-1/2 inches of weathering surfaces.

2.03 RE-BAR SPLICING:
   A. Coupler Systems: Mechanical devices for splicing reinforcing bars; capable of developing full
      steel reinforcing design strength in tension and compression.
   B. Dowel Bar Splicer with Dowel-Ins: Mechanical devices for connecting dowels; capable of
      developing full steel reinforcing design strength in tension and compression.
   C. Grout: Cementitious, non-metallic, non-shrink grout for use with manufacturer's grout sleeve
      reinforcing bar coupler system.

2.04 FABRICATION
   A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
   B. Locate reinforcing splices not indicated on drawings at point of minimum stress.
      1. Review locations of splices with Architect.

PART 3 EXECUTION

3.01 GENERAL
   A. See Structural Drawings A-100 for additional execution requirements.

3.02 PLACEMENT
   A. Place, support and secure reinforcement against displacement. Do not deviate from required
      position.
   B. Do not displace or damage vapor barrier.
   C. Accommodate placement of formed openings.
   D. Conform to applicable code for concrete cover over reinforcement.

3.03 FIELD QUALITY CONTROL
   A. Inspect installed reinforcement for conformance to contract documents before concrete
      placement.

END OF SECTION
SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Slabs on grade.
B. Concrete footings.
C. Concrete curing.

1.02 RELATED REQUIREMENTS
A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
B. Section 03 20 00 - Concrete Reinforcing.
C. See Structural Drawings A-100 for additional Project Specifications.

1.03 REFERENCE STANDARDS
A. See Structural Drawings A-100 for Reference Standards.

1.04 SUBMITTALS
A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
C. Mix Design: Submit proposed concrete mix design.
   1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
   2. Indicate proposed mix design complies with requirements of ACI 318, Chapter 5 - Concrete Quality, Mixing and Placing.
D. Test Reports: Submit report for each test or series of tests specified.
E. Manufacturer's Installation Instructions: For concrete accessories, indicate installation procedures and interface required with adjacent construction.
F. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.
G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.
H. See Structural Drawings A-100 for additional Submittal Requirements.

1.05 QUALITY ASSURANCE
A. Perform work of this section in accordance with ACI 301 and ACI 318.
B. Follow recommendations of ACI 305R when concreting during hot weather.
C. For slabs required to include moisture vapor reduction admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement.
D. Refer to Structural Drawings A-100 for additional Quality Assurance requirements and Inspection requirements.

1.06 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Moisture Emission Reducing Curing and Sealing Compound: Provide warranty to cost of flooring delamination failures for 10 years.
1. Include cost of repair or removal of failed flooring, remediation with a moisture vapor impermeable surface coating, and replacement of flooring with comparable flooring system.

PART 2 PRODUCTS

2.01 GENERAL
A. See Structural Drawings A-100 for additional product requirements.

2.02 FORMWORK
A. Comply with requirements of Section 03 10 00.

2.03 REINFORCEMENT
A. Comply with requirements of Section 03 20 00.

2.04 CONCRETE MATERIALS
A. Refer to Structural Drawings A-100 for concrete material specifications.

2.05 ACCESSORY MATERIALS
A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
   1. Accessory Products: Vapor retarder manufacturer’s recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations in vapor retarder.
   2. Products:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.06 CURING MATERIALS
A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
B. Curing and Sealing Compound, Moisture Emission Reducing: Liquid, membrane-forming, clear sealer, for application to newly placed concrete; capable of providing adequate bond for flooring adhesives, initially and over the long term; with sufficient moisture vapor impermeability to prevent deterioration of flooring adhesives due to moisture emission.
   1. Use this product to cure and seal all slabs to receive adhesively applied flooring or roofing.
   2. Comply with ASTM C309 and ASTM C1315 Type I Class A.
   3. VOC Content: Less than 100 g/L.
   5. Products:
      a. Floor Seal Technology, Inc; VaporSeal 309 System: www.floorseal.com/#sle.
      c. Nox-Crete Inc; Cure & Seal 1200E: www.nox-crete.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 CONCRETE MIX DESIGN
A. Refer to Structural Drawings A-100 for concrete mix design specifications.
PART 3 EXECUTION

3.01 GENERAL
A. See Structural Drawings A-100 for additional execution requirements.

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

3.03 PREPARATION
A. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
B. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.
C. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
   1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as shown on the drawings. Do not use sand.

3.04 PLACING CONCRETE
A. Place concrete in accordance with ACI 304R.
B. Place concrete for floor slabs in accordance with ACI 302.1R.
C. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
D. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

3.05 SLAB JOINTING
A. Locate joints as indicated on drawings.
B. Anchor joint fillers and devices to prevent movement during concrete placement.
C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
   1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
D. Load Transfer Construction and Contraction Joints: Install load transfer devices as indicated; saw cut joint at surface as indicated for contraction joints.
E. Saw Cut Contraction Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
F. Contraction Joint Devices: Use preformed joint device, with top set flush with top of slab.
G. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

3.06 FLOOR FLATNESS AND LEVELNESS TOLERANCES
A. Maximum Variation of Surface Flatness:
1. Exposed Concrete Floors: 1/4 inch in 10 ft.

B. Correct the slab surface if tolerances are less than specified.
C. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.07 CONCRETE FINISHING

A. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:
   1. Other Surfaces to Be Left Exposed: "Steel trowel" as described in ACI 302.1R, minimizing burnish marks and other appearance defects.

3.08 CURING AND PROTECTION

A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
C. Surfaces Not in Contact with Forms:
   1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
   2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
   3. Final Curing: Begin after initial curing but before surface is dry.

3.09 FIELD QUALITY CONTROL

A. Provide free access to concrete operations at project site and cooperate with appointed firm.
B. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
C. Tests of concrete and concrete materials may be performed at any time to ensure conformance with specified requirements.
D. Compressive Strength Tests: ASTM C39/C39M. For each test, mold and cure three concrete test cylinders. Obtain test samples for every 100 cu yd or less of each class of concrete placed.
E. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.

3.10 DEFECTIVE CONCRETE

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

END OF SECTION
SECTION 04 05 11
MORTAR AND MASONRY GROUT

PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Mortar for masonry.

1.02  RELATED REQUIREMENTS
   A. Section 04 20 00 - Unit Masonry: Installation of mortar and grout.
   B. See Structural Drawings A-100 for additional Project Specifications.

1.03  REFERENCE STANDARDS
   A. See Structural Drawings A-100 for Reference Standards.

1.04  SUBMITTALS
   A. See Section 01 33 00 - Submittal Procedures.
   B. Product Data: Include design mix and indicate whether the Proportion or Property specification of ASTM C270 is to be used. Also include required environmental conditions and admixture limitations.
   C. Samples: Submit two samples of mortar, illustrating mortar color and color range.
   D. See Structural Drawings A-100 for additional Submittal Requirements.

1.05  QUALITY ASSURANCE
   A. Comply with provisions of TMS 402/602, except where exceeded by requirements of the contract documents.
   B. Refer to Structural Drawings A-100 for additional Quality Assurance requirements and Inspection requirements.

1.06  DELIVERY, STORAGE, AND HANDLING
   A. Maintain packaged materials clean, dry, and protected against dampness, freezing, and foreign matter.

1.07  FIELD CONDITIONS
   A. Cold and Hot Weather Requirements: Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

PART 2  PRODUCTS
2.01  MORTAR AND GROUT APPLICATIONS
      1. Exterior Masonry Pointing Mortar: Type O; color to match existing.
      2. Masonry below grade and in contact with earth: Type S.
      3. Exterior Masonry Veneer: Type N.

2.02  MATERIALS
   A. See Structural Drawings A-100 for material requirements.

PART 3  EXECUTION
3.01  GENERAL
   A. See Structural Drawings for additional execution requirements.

3.02  INSTALLATION
   A. Install mortar to requirements of section(s) in which masonry is specified.
3.03 GROUTING

A. Use either high-lift or low-lift grouting techniques, at Contractor's option, subject to other limitations of contract documents.

B. Low-Lift Grouting:
   1. Limit height of pours to 12 inches.
   2. Limit height of masonry to 16 inches above each pour.
   3. Pour grout only after vertical reinforcing is in place; place horizontal reinforcing as grout is poured. Prevent displacement of bars as grout is poured.
   4. Place grout for each pour continuously and consolidate immediately; do not interrupt pours for more than 1-1/2 hours.

C. High-Lift Grouting:
   1. Verify that horizontal and vertical reinforcement is in proper position and adequately secured before beginning pours.
   2. Place grout for spanning elements in single, continuous pour.

END OF SECTION
SECTION 04 20 00
UNIT MASONRY

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Concrete block.
   B. Common Brick.
   C. Ceramic glazed structural clay facing tile.
   D. Accessories.

1.02 RELATED REQUIREMENTS
   A. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel for grouted masonry.
   B. Section 04 05 11 - Mortar and Masonry Grout.
   C. Section 05 50 00 - Metal Fabrications: Loose steel lintels.
   D. Section 07 90 05 - Joint Sealers: Backing rod and sealant at control and expansion joints.
   E. See Structural Drawings A-100 for additional Project Specifications.

1.03 REFERENCE STANDARDS
   A. See Structural Drawings A-100 for Reference Standards.

1.04 SUBMITTALS
   A. See Section 01 33 00 - Submittal Procedures.
   B. Product Data: Provide data for masonry units, mortar, and masonry accessories.
   C. Samples: Submit four samples of brick units to illustrate color, texture, and extremes of color range.
   D. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.

1.05 QUALITY ASSURANCE
   A. Comply with provisions of TMS 402/602, except where exceeded by requirements of the contract documents.
      1. Maintain one copy of each document on project site.
   B. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section with minimum ten years of documented experience.
   C. Installer Qualifications: Company specializing in performing work of the type specified and with at least ten years of documented experience.
   D. Refer to Structural Drawings for additional Quality Assurance requirements and Inspection requirements.

1.06 MOCK-UP
   A. Construct a mock-up panel of size, detail and configuration indicated on the drawings. Mock-up shall include all components of the exterior wall construction.
   B. Locate where directed.
   C. The approved mock-up panel shall serve as the standard of quality for construction and shall remain in place until the building shell is complete and until directed to be removed by the Architect.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
1.08 ENVIRONMENTAL REQUIREMENTS
   A. Maintain materials and surrounding air temperature to minimum 40 degrees F prior to, during, and 48 hours after completion of masonry work.
   B. Maintain materials and surrounding air temperature to maximum 90 degrees F prior to, during, and 48 hours after completion of masonry work.

1.09 EXTRA MATERIALS
   A. See Section 01 60 00 - Product Requirements, for additional provisions.
   B. Provide 50 of each size, color, and type of brick units for Owner use in maintenance of project.

PART 2 PRODUCTS

2.01 GENERAL
   A. See Structural Drawings A-100 for additional product requirements.

2.02 CONCRETE MASONRY UNITS
   A. Concrete Block: Comply with referenced standards and as follows:
      1. Size: Standard units with nominal face dimensions of 16 x 8 inches and nominal depths as indicated on the drawings for specific locations.
      2. Load-Bearing Units: ASTM C90, normal weight.
         a. Both hollow and solid block, as indicated.
         b. Exposed faces: Manufacturer's standard color and texture.

2.03 BRICK UNITS
   A. Facing Brick: ASTM C216, Type FBX, Grade SW.
      1. Type, color and texture: Match existing brick.
      2. Nominal size: As indicated on drawings.
      3. Special shapes: Molded units as required by conditions indicated, unless standard units can be sawn to produce equivalent effect.
      4. Compressive strength: Min. 3,000 p.s.i., measured in accordance with ASTM C 67.

2.04 CLAY TILE UNITS
   A. Manufacturers:
      1. Elgin Butler Company; ______: www.elginbutler.com/#sle.
      3. Substitutions: See section 01 60 00 - Product Requirements.
   B. Ceramic Glazed Structural Clay Facing Tile: ASTM C126; Grade S (Select); Type I (single-faced units).
      1. Size: 6T Series, thickness as indicated.
      2. Special shapes: Molded units as required by conditions indicated, unless standard units can be sawn without chipping to produce equivalent effect.

2.05 MORTAR AND GROUT MATERIALS
   A. Mortar and grout: As specified in Section 04 05 11.

2.06 REINFORCEMENT AND ANCHORAGE
   A. Manufacturers of Joint Reinforcement and Anchors:
      5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Single Wythe Joint Reinforcement: Truss or Ladder type; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B-2; 0.1483 inch side rods with 0.1483 inch cross rods; width as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage on each exposure.

C. Adjustable Multiple Wythe Joint Reinforcement: Truss or Ladder type with adjustable ties spaced at 16 in on center and fabricated with moisture drip; ASTM A 82/A 82M steel wire, hot dip galvanized after fabrication to ASTM A 153/A 153M, Class B; or stainless steel wire conforming to ASTM A 580/A 580M Type 304.0.1875 inch side rods with 0.1483 inch cross rods and adjustable components of 0.1875 inch wire; width of components as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from each masonry face.
   1. Vertical adjustment: Not less than 2 inches.
   2. Insulation Clips: Provide clips at tabs or ties designed to secure insulation against outer face of inner wythe of masonry.

D. Strap Anchors: Bent steel shapes configured as required for specific situations, 2 in width, 0.1875 in thick, lengths as required to provide not more than 1 inch and not less than 1/2 inch of mortar coverage from masonry face, corrugated for embedment in masonry joint, hot dip galvanized to ASTM A 153/A 153M, Class B-2 or stainless steel.
   1. Strap anchors may only be used where

E. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B-2; stainless steel.
   1. Anchor channel: Not less than 0.120 inch thick, designed for fastening to structural backup by non corrodeable fasteners;
   2. Wire ties: Triangular; Trapezoidal; Rectangular or Manufacturer's standard shape, 0.1875 inch thick.
   3. Vertical adjustment: Not less than 3-1/2 inches.
   4. Size: Coordinate to bridge insulation and air space.
   5. Basis of Design: Hohman and Barnard, HB-213,

2.07 FLASHINGS
A. Copper/Polymer Film or Fabric Flashing - Self-Adhering: 7 oz/sq ft copper sheet bonded on both sides to a sheet of polymer film that has a clear adhesive with a removable release liner.
   1. Manufacturers:
      a. Hohmann & Barnard, Inc; Copper-Fabrick SA: www.h-b.com/#sle.
      b. Substitutions: See Section 01 60 00 - Product Requirements.

B. Drip Edge: Stainless steel; angled drip with hemmed edge; compatible with membrane and adhesives.
   1. Manufacturers:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

C. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.

2.08 ACCESSORIES
A. Preformed Control Joints: Rubber or neoprene material.
   1. Manufacturers:
      b. Hohmann & Barnard, Inc (including Dur-O-Wal brand); Product RS or VS: www.h-b.com/#sle.
C. Substitutions: See Section 01 60 00 - Product Requirements.

B. Joint Filler: Closed cell polyethylene; polyurethane or rubber oversized 50 percent to joint width; self expanding; 1 inch wide design width x by maximum lengths available.
   1. Manufacturers:
      c. Substitutions: See Section 01 60 00 - Product Requirements.

C. Reglets: As specified on Section 07 62 00.

D. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
   1. Mortar Diverter: Panels designed for installation at flashing locations.
      a. Manufacturers:
         1) Advanced Building Products, Inc; Mortar Break DT: www.advancedbuildingproducts.com/#sle.
         4) Substitutions: See Section 01 60 00 - Product Requirements.

E. Weeps: Open head.

F. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

2.09 MORTAR AND GROUT MIXES
A. Mortar and Grout mixes as specified in Section 04 05 11.

PART 3 EXECUTION
3.01 GENERAL
A. See Structural Drawings A-100 for additional execution requirements.

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

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

3.04 COURSING
A. Establish lines, levels, and coursing indicated. Protect from displacement.
B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
C. Concrete Masonry Units:
   1. Bond: Running.
   2. Coursing: One unit and one mortar joint to equal 8 inches.
   3. Foundation Mortar Joints: Flush struck or to match existing unless noted otherwise below.
D. Brick Units:
   1. Bond: Running.
      a. Match existing 1/3 bond if Norman brick are provided.
2. Vertical Coursing: Three units and three mortar joints to equal 8 inches.
E. Clay Tile Units:

3.05 PLACING AND BONDING
A. Lay solid masonry units in full bed of mortar, with full head joints, uniformly jointed with other work.
B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
C. Remove excess mortar and mortar smears as work progresses.
D. Interlock intersections and external corners.
E. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
F. Set reglets as shown on plans.
G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

3.06 WEEPS
A. Install weeps in veneer walls at 24 inches on center horizontally above opening, above through-wall flashing and at bottom of walls.

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

3.08 REINFORCEMENT AND ANCHORAGE - GENERAL
A. Fasten anchors to structural framing and embed in masonry joints as masonry is laid. Unless otherwise indicated on drawings or closer spacing is indicated under specific wall type, space anchors at maximum of 16 inches horizontally and 16 inches vertically.
B. Embed ties and anchors in mortar joint and extend into masonry unit a minimum of 1-1/2 inches with at least 5/8 inch mortar cover to the outside face of the anchor.

3.09 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER
A. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 16 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

3.10 MASONRY FLASHINGS
A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
1. Extend flashings full width at such interruptions and at least 8 inches into adjacent masonry and turn up at least 2 inches to form watertight pan at non-masonry construction.
2. Remove or cover protrusions or sharp edges that could puncture flashings.
3. Seal lapped ends and penetrations of flashing before covering with mortar.
B. Terminate flashing up 8 inches minimum on vertical surface of backing:
C. Extend laminated flashings to within 1/2 inch of exterior face of masonry and adhere to top of stainless steel angled drip with hemmed edge.
D. Lap end joints of flashings at least 4 inches and seal watertight with mastic or elastic sealant, type as recommended by flashing manufacturer.
3.11 GROUTED COMPONENTS
A. Reinforce bond beams as shown on plans.
B. Lap splices minimum 40 bar diameters.
C. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
D. Place and consolidate grout fill without displacing reinforcing.
E. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.12 CONTROL AND EXPANSION JOINTS
A. Do not continue horizontal joint reinforcement through control and expansion joints.
B. Form control joint with a sheet building paper bond breaker fitted to one side of the hollow contour end of the block unit. Fill the resultant core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
C. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
D. Size control joints as indicated on drawings; if not indicated, 3/8 inch wide and deep.
E. Locate per drawings; if not indicated, provide every 20' horizontally.

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

3.14 TOLERANCES
A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft.
C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 20ft.
E. Maximum Variation of Joint Thickness: 1/8 inch in 3 ft.
F. Maximum Variation from Cross Sectional Thickness of Walls: 1/4 inch.

3.15 CUTTING AND FITTING
A. Cut and fit for chases, pipes, conduit, sleeves, and grounds. Coordinate with other sections of work to provide correct size, shape, and location.
B. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

3.16 FIELD QUALITY CONTROL
A. Concrete Masonry Unit Tests: Test each variety of concrete unit masonry in accordance with ASTM C140 for conformance to requirements of this specification.
B. Mortar Tests: Test each type of mortar in accordance with ASTM C780, testing with same frequency as masonry samples.

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

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

END OF SECTION
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PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Architectural cast stone.
   B. Units required are indicated on drawings as "cast stone".
   C. Units required are:
      1. Exterior wall units, including sills.

1.02 RELATED REQUIREMENTS
   A. Section 04 05 11 - Mortar and Masonry Grout: Mortar for setting cast stone.
   B. Section 04 20 00 - Unit Masonry: Installation of cast stone in conjunction with masonry.
   C. Section 07 90 05 - Joint Sealers: Materials and execution methods for sealing soft joints in cast stone work.

1.03 REFERENCE STANDARDS
   A. ACI 318 - Building Code Requirements for Structural Concrete.
   B. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   C. ASTM A767/A767M - Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   F. ASTM C33/C33M - Standard Specification for Concrete Aggregates.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Test results of cast stone components made previously by the manufacturer.
      1. Include one copy of ASTM C1364 for Architect's use.
   C. Shop Drawings: Include elevations, dimensions, layouts, profiles, cross sections, reinforcement, exposed faces, arrangement of joints, anchoring methods, anchors, and piece numbers.
   D. Mortar Color Selection Samples.
   E. Manufacturer's Qualification Data: Documentation showing compliance with specified requirements.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications:
      1. A firm with a minimum of 10 years experience producing cast stone of types required for project.
2. Current producer member of the Cast Stone Institute or the Architectural Precast Association.
3. Adequate plant capacity to furnish quality, sizes, and quantity of cast stone required without delaying progress of the work.

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

1.06 MOCK-UP
A. See Section 01 40 00 - Quality Requirements for additional requirements.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver cast stone components secured to shipping pallets and protected from damage and discoloration. Protect corners from damage.
B. Number each piece individually to match shop drawings and schedule.
C. Store cast stone components and installation materials in accordance with manufacturer's instructions.
D. Store cast stone components on pallets with nonstaining, waterproof covers. Ventilate under covers to prevent condensation. Prevent contact with dirt.
E. Protect cast stone components during handling and installation to prevent chipping, cracking, or other damage.
F. Store mortar materials where contamination can be avoided.
G. Schedule and coordinate production and delivery of cast stone components with unit masonry work to optimize on-site inventory and to avoid delaying the work.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Architectural Cast Stone:
   1. Any current producer member of the Architectural Precast Association.
   2. Any current producer member of the Cast Stone Institute.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ARCHITECTURAL CAST STONE
   1. Compressive Strength: As specified in ASTM C1364; calculate strength of pieces to be field cut at 80 percent of uncut piece.
   2. Freeze-Thaw Resistance: Demonstrated by laboratory testing in accordance with ASTM C1364.
   3. Surface Texture: Fine grained texture, with no bugholes, air voids, or other surface blemishes visible from distance of 20 feet.
   4. Remove cement film from exposed surfaces before packaging for shipment.
B. Shapes: Provide shapes indicated on drawings.
   1. Variation from Any Dimension, Including Bow, Camber, and Twist: Maximum of plus/minus 1/8 inch or length divided by 360, whichever is greater, but not more than 1/4 inch.
   2. Unless otherwise indicated on drawings, provide:
      a. Wash or slope of 1:12 on exterior horizontal surfaces.
      b. Drips on projecting components, wherever possible.
c. Raised fillets at back of sills and at ends to be built in.

C. Reinforcement: Provide reinforcement as required to withstand handling and structural stresses; comply with ACI 318.

2.03 MATERIALS
A. Portland Cement: ASTM C150/C150M.
   1. For Mortar: Type I or II, except Type III may be used in cold weather.
B. Coarse Aggregate: ASTM C33/C33M, except for gradation; granite, quartz, or limestone.
C. Fine Aggregate: ASTM C33/C33M, except for gradation; natural or manufactured sands.
D. Admixtures: ASTM C494/C494M.
E. Water: Potable.
F. Reinforcing Bars: ASTM A615/A615M, Grade 40 (40,000 psi), deformed bars, galvanized.
   1. Galvanized in accordance with ASTM A767/A767M, Class I.
H. Embedded Anchors, Dowels, and Inserts: Type 304 stainless steel, of type and size as required for conditions.
I. Mortar: Portland cement-lime, as specified in Section 04 05 11; do not use masonry cement.
J. Cleaner: General-purpose cleaner designed for removing mortar and grout stains, efflorescence, and other construction stains from new masonry surfaces without discoloring or damaging masonry surfaces; approved for intended use by cast stone manufacturer and by cleaner manufacturer for use on cast stone and adjacent masonry materials.

PART 3 EXECUTION
3.01 EXAMINATION
A. Examine construction to receive cast stone components. Notify Architect if construction is not acceptable.
B. Do not begin installation until unacceptable conditions have been corrected.

3.02 INSTALLATION
A. Install cast stone components in conjunction with masonry, complying with requirements of Section 04 20 00.
B. Mechanically anchor cast stone units indicated; set remainder in mortar.
C. Setting:
   1. Drench cast stone components with clear, running water immediately before installation.
   2. Set units in a full bed of mortar unless otherwise indicated.
   3. Fill vertical joints with mortar.
   4. Fill dowel holes and anchor slots completely with mortar or non-shrink grout.

3.03 TOLERANCES
A. Joints: Make all joints 3/8 inch, except as otherwise detailed.
B. Installation Tolerances:
   1. Variation from Plumb: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet or more.
   2. Variation from Level: Not more than 1/8 inch in 10 feet or 1/4 inch in 20 feet, or 3/8 inch maximum.
   3. Variation in Joint Width: Not more than 1/8 inch in 36 inches or 1/4 of nominal joint width, whichever is less.
4. Variation in Plane Between Adjacent Surfaces (Lipping): Not more than 1/16 inch difference between planes of adjacent units or adjacent surfaces indicated to be flush with units.

3.04 REPAIR
   A. Repair chips and other surface damage noticeable when viewed in direct daylight at 10 feet.
   B. Repair with matching touch-up material provided by the manufacturer and in accordance with manufacturer’s instructions.
   C. Repair methods and results subject to Architect’s approval.

3.05 CLEANING
   A. Clean completed exposed cast stone after mortar is thoroughly set and cured.
      1. Wet surfaces with water before applying cleaner.
      2. Apply cleaner to cast stone in accordance with manufacturer’s instructions.
      3. Remove cleaner promptly by rinsing thoroughly with clear water.
      4. Do not use acidic cleaners.
   B. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

3.06 PROTECTION
   A. Protect completed work from damage.
   B. Clean, repair, or restore damaged or mortar-splashed work to condition of new work.

END OF SECTION
SECTION 05 12 00
STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Structural steel framing members.
B. Base plates, shear stud connectors and expansion joint plates.
C. Grouting under base plates.

1.02 RELATED REQUIREMENTS
A. Section 05 21 00 - Steel Joist Framing.
B. Section 05 31 00 - Steel Decking: Support framing for small openings in deck.
C. Section 05 50 00 - Metal Fabrications: Steel fabrications affecting structural steel work.
D. See Structural Drawings A-100 for additional Project Specifications.

1.03 REFERENCE STANDARDS
A. See Structural Drawings A-100 for Reference Standards.

1.04 SUBMITTALS
A. See Section 01 33 00 - Submittal Procedures.
B. Shop Drawings:
   1. Indicate profiles, sizes, spacing, locations of structural members, openings, attachments, and fasteners.
   2. Connections not detailed.
   3. Indicate welded connections with AWS A2.4 welding symbols. Indicate net weld lengths.
C. Manufacturer's Mill Certificate: Certify that products meet or exceed specified requirements.
D. See Structural Drawings A-100 for additional Submittal Requirements.

1.05 QUALITY ASSURANCE
A. Fabricate structural steel members in accordance with AISC (MAN) "Steel Construction Manual."
B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and no more than 12 months before start of scheduled welding work.
C. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.
D. Erector: Company specializing in performing the work of this section with minimum ten years of documented experience.
E. Design connections not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
F. Refer to Structural Drawings A-100 for additional Quality Assurance requirements and Inspection requirements.

PART 2 PRODUCTS

2.01 MATERIALS
A. See Structural Drawings A-100 for material requirements.
2.02 FABRICATION
   A. Shop fabricate to greatest extent possible.

2.03 FINISH
   A. Shop prime structural steel members. Do not prime surfaces that will be fireproofed.
   B. All steel exposed to weather shall be painted with rust inhibitive primer and hot dipped galvanized.

PART 3 EXECUTION
3.01 GENERAL
   A. See Structural Drawings A-100 for additional execution requirements.

3.02 EXAMINATION
   A. Verify that conditions are appropriate for erection of structural steel and that the work may properly proceed.

3.03 ERECTION
   B. Allow for erection loads and provide sufficient temporary bracing to maintain structure in safe condition, plumb, and in true alignment until completion of erection and installation of permanent bracing.
   C. Do not field cut or alter structural members without approval of Engineer.
   D. After erection, prime welds, abrasions, and surfaces not shop primed, except surfaces to be in contact with concrete.
   E. Grout solidly between column plates and bearing surfaces, complying with manufacturer's instructions for nonshrink grout. Trowel grouted surfaces smooth, splaying neatly to 45 degrees.

END OF SECTION
SECTION 05 21 00
STEEL JOIST FRAMING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Open web steel joists, with bridging, attached seats and anchors.

1.02 RELATED REQUIREMENTS
   A. Section 05 12 00 - Structural Steel Framing: Grouting base plates and bearing plates.
      Superstructure framing.
   B. Section 05 31 00 - Steel Decking: Bearing plates and angles.
   C. Section 05 50 00 - Metal Fabrications: Non-framing steel fabrications attached to joists.

1.03 REFERENCE STANDARDS
   A. AWS D1.1/D1.1M - Structural Welding Code - Steel.
   B. IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172.
   C. SJI 100 - Standard Specifications for K-Series, LH-Series, and DLH-Series Open Web Steel Joists, and for Joist Girders.
   D. SJI Technical Digest No. 9 - Handling and Erection of Steel Joists and Joist Girders.
   E. SSPC-Paint 15 - Steel Joist Shop Primer/Metal Building Primer.
   F. SSPC-SP 2 - Hand Tool Cleaning.
   G. See Structural Drawings A-100 for Reference Standards.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings: Indicate standard designations, joist coding, configurations, sizes, spacings, cambers, locations of joists, joist leg extensions, bridging, connections, and attachments.

1.05 QUALITY ASSURANCE
   A. Design connections not detailed on drawings under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
   B. Perform Work, including that for headers and other supplementary framing, in accordance with SJI 100 Standard Specifications Load Tables and SJI Technical Digest No. 9.
   C. Manufacturer Qualifications: Company specializing in performing the work of this section with minimum ten years documented experience.
   D. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Transport, handle, store, and protect products to SJI requirements.

PART 2 PRODUCTS

2.01 MATERIALS
   A. Open Web Joists: SJI Type K Joists:
      1. Provide bottom chord extensions as indicated.
      2. Minimum End Bearing on Steel Supports: Comply with referenced SJI standard.
3. Minimum End Bearing on Concrete or Masonry Supports: Comply with referenced SJI standard.
4. Finish: Shop primed.
   B. Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.
   C. Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

2.02 FINISH
   A. Shop prime joists as specified.
   B. Prepare surfaces to be finished in accordance with SSPC-SP 2.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions prior to beginning work.

3.02 ERECTION
   A. Erect joists with correct bearing on supports.
   B. Allow for erection loads. Provide sufficient temporary bracing to maintain framing safe, plumb, and in true alignment.
   C. After joist alignment and installation of framing, field weld joist seats to steel bearing surfaces.
   D. Do not permit erection of decking until joists are braced, bridged, and secured or until completion of erection and installation of permanent bridging and bracing.
   E. Do not field cut or alter structural members without approval of joist manufacturer.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Acoustical roof deck.
   B. Roof deck.
   C. Supplementary framing for openings up to and including 18 inches.

1.02  RELATED REQUIREMENTS
   A. Section 05 12 00 - Structural Steel Framing.
   B. Section 05 21 00 - Steel Joist Framing.
   C. See Structural Drawings A-100 for additional Project Specifications.

1.03  REFERENCE STANDARDS
   A. See Structural Drawings A-100 for Reference Standards.

1.04  SUBMITTALS
   A. See Section 01 33 00 - Submittal Procedures, for submittals procedures.
   B. Product Data: Provide deck profile characteristics, dimensions, structural properties, and finishes.
   C. Shop Drawings: Indicate deck plan, support locations, projections, openings, reinforcement, pertinent details, and accessories.
   D. Certificates: Certify that products furnished meet or exceed specified requirements.
   E. See Structural Drawings A-100 for additional Submittal Requirements.

1.05  QUALITY ASSURANCE
   A. Design deck layout, spans, fastening, and joints under direct supervision of a Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located.
   B. Welder Qualifications: Welding processes and welding operators qualified in accordance with AWS D1.1/D1.1M and AWS D1.3/D1.3M and dated no more than 12 months before start of scheduled welding work.
   C. Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.
   D. Installer Qualifications: Company specializing in performing the work of this Section with minimum ten years of experience.
   E. Refer to Structural Drawings for additional Quality Assurance requirements and Inspection requirements.

1.06  DELIVERY, STORAGE, AND HANDLING
   A. Cut plastic wrap to encourage ventilation.
   B. Separate sheets and store deck on dry wood sleepers; slope for positive drainage.

PART 2  PRODUCTS

2.01  MATERIALS
   A. See Structural Drawings A-100 for material requirements.
PART 3 EXECUTION

3.01 GENERAL
   A. See Structural Drawings A-100 for additional execution requirements.

3.02 EXAMINATION
   A. Verify existing conditions prior to beginning work.

3.03 INSTALLATION
   A. Erect metal deck in accordance with SDI Design Manual and manufacturer's instructions. Align and level.

END OF SECTION
SECTION 05 52 13
PIPE AND TUBE RAILINGS

PART 1  GENERAL

1.01  SECTION INCLUDES
   A.  Free-standing railings at steps.

1.02  RELATED REQUIREMENTS
   A.  Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B.  Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
   C.  Section 03 30 00 - Cast-in-Place Concrete: Placement of anchors in concrete.
   D.  Section 04 20 00 - Unit Masonry: Placement of anchors in masonry.

1.03  REFERENCE STANDARDS
   A.  ADA Standards - 2010 ADA Standards for Accessible Design.
   D.  ASTM A500/A500M - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   G.  IAS AC172 - Accreditation Criteria for Fabricator Inspection Programs for Structural Steel AC172.
   H.  SSPC-Paint 20 - Zinc-Rich Coating (Type I - Inorganic, and Type II - Organic).

1.04  SUBMITTALS
   A.  See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B.  Shop Drawings: Indicate profiles, sizes, connection attachments, anchorage, size and type of fasteners, and accessories.

1.05  QUALITY ASSURANCE
   A.  Structural Designer Qualifications: Professional Structural Engineer experienced in design of this work and licensed in the State in which the Project is located, or personnel under direct supervision of such an engineer.
   B.  Fabricator Qualifications: A qualified steel fabricator that is accredited by the International Accreditation Service (IAS) Fabricator Inspection Program for Structural Steel in accordance with IAS AC172.
   C.  Installer Qualifications: Company specializing in performing the work of this Section with minimum ten years of experience.

PART 2  PRODUCTS

2.01  RAILINGS - GENERAL REQUIREMENTS
   A.  Design, fabricate, and test railing assemblies in accordance with the most stringent requirements of ASTM E985 and applicable local code.
B. Distributed Loads: Design railing assembly, wall rails, and attachments to resist distributed force of 75 pounds per linear foot applied to the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935.

C. Concentrated Loads: Design railing assembly, wall rails, and attachments to resist a concentrated force of 200 pounds applied at any point on the top of the assembly and in any direction, without damage or permanent set. Test in accordance with ASTM E935.

D. Allow for expansion and contraction of members and building movement without damage to connections or members.

E. Dimensions: See drawings for configurations and heights.
1. Top Rails and Wall Rails: 1-1/2 inches nominal diameter, round.
4. Balusters: 1/2 inch square solid bar.

F. Provide anchors and other components as required to attach to structure, made of same materials as railing components unless otherwise indicated; where exposed fasteners are unavoidable provide flush countersunk fasteners.
1. For anchorage to concrete, provide inserts to be cast into concrete, for bolting anchors.
2. For anchorage to masonry, provide brackets to be embedded in masonry, for bolting anchors.
3. For anchorage to stud walls, provide backing plates, for bolting anchors.

2.02 STEEL RAILING SYSTEM

A. Steel Tube: ASTM A500, Grade B cold-formed structural tubing.
B. Steel Pipe: ASTM A53/A53M, Grade B Schedule 80, black finish.
C. Welding Fittings: Factory- or shop-welded from matching pipe or tube; seams continuously welded; joints and seams ground smooth.
D. Exposed Fasteners: No exposed bolts or screws.
E. Straight Splice Connectors: Steel concealed spigots.
F. Galvanizing at exterior railings: In accordance with requirements of ASTM A123/A123M.
1. Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic.

2.03 FABRICATION

A. Accurately form components to suit specific project conditions and for proper connection to building structure.
B. Fit and shop assemble components in largest practical sizes for delivery to site.
C. Fabricate components with joints tightly fitted and secured. Provide spigots and sleeves to accommodate site assembly and installation.
D. Welded Joints:
1. Exterior Components: Continuously seal joined pieces by intermittent welds and plastic filler. Drill condensate drainage holes at bottom of members at locations that will not encourage water intrusion.
2. Interior Components: Continuously seal joined pieces by intermittent welds and plastic filler.
3. Grind exposed joints flush and smooth with adjacent finish surface. Make exposed joints butt tight, flush, and hairline. Ease exposed edges to small uniform radius.
PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field conditions are acceptable and are ready to receive work.

3.02 PREPARATION
A. Clean and strip primed steel items to bare metal where site welding is required.
B. Supply items required to be cast into concrete or embedded in masonry with setting templates, for installation as work of other sections.

3.03 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Install components plumb and level, accurately fitted, free from distortion or defects, with tight joints.
C. Install railings in compliance with ADA Standards for accessible design at applicable locations.
D. Anchor railings securely to structure.
E. Conceal anchor bolts and screws whenever possible. Where not concealed, use flush countersunk fastenings.

3.04 TOLERANCES
A. Maximum Variation From Plumb: 1/4 inch per floor level, non-cumulative.
B. Maximum Offset From True Alignment: 1/4 inch.

END OF SECTION
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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Rough opening framing for doors, windows, and roof openings.
   B. Roofing nailers.
   C. Preservative treated wood materials.
   D. Fire retardant treated wood materials.
   E. Miscellaneous framing and sheathing.
   F. Communications and electrical room mounting boards.
   G. Wood nailers and curbs for roofing and items installed on roof.
   H. Concealed wood blocking, nailers, and supports.
   I. Miscellaneous wood nailers, furring, and grounds.

1.02 RELATED REQUIREMENTS
   A. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
   B. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS
   G. SPIB (GR) - Grading Rules.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. See Section 01 33 00 - Submittal Procedures.
   C. Product Data: Provide technical data on wood preservative materials and application instructions.
   D. Manufacturer's Certificate: Certify that wood products supplied for rough carpentry meet or exceed specified requirements.

1.05 QUALITY ASSURANCE
   A. Lumber: Comply with PS 20 and approved grading rules and inspection agencies.
      1. Lumber of other species or grades, or graded by other agencies, is acceptable provided structural and appearance characteristics are equivalent to or better than products specified.
   B. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
C. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

**1.06 DELIVERY, STORAGE, AND HANDLING**

A. General: Cover wood products to protect against moisture. Support stacked products to prevent deformation and to allow air circulation.

B. Fire Retardant Treated Wood: Prevent exposure to precipitation during shipping, storage, or installation.

**PART 2 PRODUCTS**

**2.01 GENERAL REQUIREMENTS**

A. Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.
   1. Species: Douglas Fir-Larch, unless otherwise indicated.
   2. If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.
   3. Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

B. Lumber fabricated from old growth timber is not permitted.

C. Provide sustainably harvested wood.

**2.02 DIMENSION LUMBER FOR CONCEALED APPLICATIONS**

A. Grading Agency: Southern Pine Inspection Bureau, Inc. (SPIB).

B. Sizes: Nominal sizes as indicated on drawings, S4S.

C. Moisture Content: S-dry or MC19.

D. Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:
   1. Lumber: S4S No. 2 or Standard Grade.
   2. Boards: Standard or No. 3.

E. Miscellaneous Blocking, Furring, Nailers, and Curbs:
   1. Lumber: S4S, No. 1 or Construction Grade.

**2.03 CONSTRUCTION PANELS**

A. Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

**2.04 ACCESSORIES**

A. Fasteners and Anchors:
   1. Metal and Finish: Hot-dipped galvanized steel per ASTM A 153/A 153M; or Stainless Steel for high humidity and preservative-treated wood locations, unfinished steel elsewhere.
   2. Drywall Screws: Bugle head, hardened steel, power driven type, length three times thickness of sheathing.
   3. Anchors: Toggle bolt type for anchorage to hollow masonry.
2.05 FACTORY WOOD TREATMENT

A. Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.
   1. Fire-Retardant Treated Wood: Mark each piece of wood with producer's stamp indicating compliance with specified requirements.
   2. Preservative-Treated Wood: Provide lumber and plywood marked or stamped by an ALSC-accredited testing agency, certifying level and type of treatment in accordance with AWPA standards.

B. Fire Retardant Treatment:
   1. Manufacturers:
      d. Substitutions: Not permitted.
   2. Exterior Type: AWPA U1, Category UCFB, Commodity Specification H, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes both before and after accelerated weathering test performed in accordance with ASTM D2898.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      b. Do not use treated wood in direct contact with the ground.
   3. Interior Type A: AWPA U1, Use Category UCFA, Commodity Specification H, low temperature (low hygroscopic) type, chemically treated and pressure impregnated; capable of providing a maximum flame spread rating of 25 when tested in accordance with ASTM E84, with no evidence of significant combustion when test is extended for an additional 20 minutes.
      a. Kiln dry wood after treatment to a maximum moisture content of 19 percent for lumber and 15 percent for plywood.
      b. Treat rough carpentry items as scheduled; or as indicated.
      c. Do not use treated wood in applications exposed to weather or where the wood may become wet.

C. Preservative Treatment:
   1. Manufacturers:
      d. Substitutions: Not permitted.

D. Preservative Pressure Treatment of Lumber Above Grade: AWPA U1, Use Category UC3B, Commodity Specification A using waterborne preservative to 0.25 lb/cu ft retention.
   1. Kiln dry lumber after treatment to maximum moisture content of 19 percent.
   2. Treat lumber in contact with roofing, flashing, or waterproofing.
   3. Treat lumber in contact with masonry or concrete.
   4. Treat lumber less than 18 inches above grade.
      a. Treat lumber in other locations as indicated.
   5. Preservative Pressure Treatment of Plywood Above Grade: AWPA U1, Use Category UC2 and UC3B, Commodity Specification F using waterborne preservative to 0.25 lb/cu ft retention.
      a. Kiln dry plywood after treatment to maximum moisture content of 15 percent.
b. Treat plywood in contact with masonry or concrete.

PART 3 EXECUTION
3.01 INSTALLATION - GENERAL
A. Select material sizes to minimize waste.
B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
C. Where treated wood is used on interior, provide temporary ventilation during and immediately after installation sufficient to remove indoor air contaminants.

3.02 FRAMING INSTALLATION
A. Select material sizes to minimize waste.
B. Reuse scrap to the greatest extent possible; clearly separate scrap for use on site as accessory components, including: shims, bracing, and blocking.
C. Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.
D. Make provisions for temporary construction loads, and provide temporary bracing sufficient to maintain structure in true alignment and safe condition until completion of erection and installation of permanent bracing.
E. Install structural members full length without splices unless otherwise specifically detailed.
F. Comply with member sizes, spacing, and configurations indicated, and fastener size and spacing indicated, but not less than required by applicable codes and AFPA Wood Frame Construction Manual.

3.03 BLOCKING, NAILERS, AND SUPPORTS
A. Provide framing and blocking members as indicated or as required to support finishes, fixtures, specialty items, and trim.
B. In metal stud walls, provide continuous blocking around door and window openings for anchorage of frames, securely attached to stud framing.
C. In walls, provide blocking attached to studs as backing and support for wall-mounted items, unless item can be securely fastened to two or more studs or other method of support is explicitly indicated.
D. Where ceiling-mounting is indicated, provide blocking and supplementary supports above ceiling, unless other method of support is explicitly indicated.
E. Specifically, provide the following non-structural framing and blocking:
   1. Cabinets and shelf supports.
   2. Wall brackets.
   3. Handrails.
   4. Grab bars.
   5. Bath accessories.
   6. Wall-mounted door stops.
   7. Visual display and marker boards.
   8. Wall paneling and trim.
   9. Joints of rigid wall coverings that occur between studs.

3.04 ROOF-RELATED CARPENTRY
A. Coordinate installation of roofing carpentry with deck construction, framing of roof openings, and roofing assembly installation.
3.05 INSTALLATION OF ACCESSORIES AND MISCELLANEOUS WOOD
   A. Curb roof openings except where prefabricated curbs are provided. Form corners by
      alternating lapping side members.
   B. Coordinate curb installation with installation of decking and support of deck openings, roofing
      vapor retardant, and parapet construction.

3.06 INSTALLATION OF CONSTRUCTION PANELS
   A. Communications and Electrical Room Mounting Boards: Secure with screws to studs with
      edges over firm bearing; space fasteners at maximum 24 inches on center on all edges and
      into studs in field of board.
      1. At fire-rated walls, install board over wall board indicated as part of the fire-rated
         assembly.
      2. Where boards are indicated as full floor-to-ceiling height, install with long edge of board
         parallel to studs.
      3. Install adjacent boards without gaps.

3.07 TOLERANCES
   A. Framing Members:  1/4 inch from true position, maximum.
   B. Surface Flatness of Floor:  1/8 inch in 10 feet maximum, and 1/4 inch in 30 feet maximum.
   C. Variation from Plane (Other than Floors):  1/4 inch in 10 feet maximum, and 1/4 inch in 30 feet
      maximum.

3.08 CLEANING
   A. Waste Disposal: Comply with the requirements of Section 01 7419 - Construction Waste
      Management and Disposal.
      1. Comply with applicable regulations.
      2. Do not burn scrap on project site.
      3. Do not burn scraps that have been pressure treated.
      4. Do not send materials treated with pentachlorophenol, CCA, or ACA to co-generation
         facilities or “waste-to-energy” facilities.
   B. Do not leave any wood, shavings, sawdust, etc. on the ground or buried in fill.
   C. Prevent sawdust and wood shavings from entering the storm drainage system.

END OF SECTION
SECTION 06 41 00
ARCHITECTURAL WOOD CASEWORK

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Specially fabricated cabinet units.
B. Countertops.
C. Cabinet hardware.
D. Window Sills.

1.02 RELATED REQUIREMENTS
A. Section 06 10 00 - Rough Carpentry: Support framing, grounds, and concealed blocking.
B. Section 09 65 00 – Resilient Flooring: Base molding.
C. Section 22 40 00 – Plumbing Fixtures: Sinks and service fixtures, service waste lines, connections, and vents.
D. Section 26 27 26 – Wiring Devices: Electrical service fixtures:

1.03 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, units with full glass insert doors and/or acrylic doors, and units with wire grille doors.
   2. Closed Interiors: Any closed storage unit behind solid door or drawer fronts.
   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 72 inches above furnished floor.
   5. Semi-Exposed Surfaces: Interior surfaces which are visible, bottoms of wall cabinets and tops of cabinets 72 inches or more above finished floor.

1.04 REFERENCE STANDARDS
E. AWMAC/WI (NAAWS) - North American Architectural Woodwork Standards.
F. BHMA A156.9 - Cabinet Hardware.
G. ISFA 2-01 - Classification and Standards for Solid Surfacing Material.
H. NEMA LD 3 - High-Pressure Decorative Laminates.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 33 00 - Submittal Procedures.
C. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories.
D. Product Data: Provide data for hardware accessories.
1.06 QUALITY ASSURANCE

A. Quality Standard: Unless otherwise indicated, comply with AWI’s Architectural Woodwork Quality Standards for grades of interior architectural woodwork, construction, finishes and other requirements.

B. Single Source Manufacturer: Casework, countertops and architectural millwork products must all be engineered and built by a single source manufacturer in order to ensure consistency and quality for these related products. Splitting casework, countertops and/or architectural millwork between multiple manufacturers will not be permitted.

C. Fabricator Qualifications: Company specializing in fabricating the products specified in this section with minimum five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect units from moisture damage.

B. Deliver completed laminate clad casework, countertops, and related products 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.

C. Protect finished surfaces from soiling and damage during handling and installation with a protective covering.

D. Do not deliver or install woodwork until building is enclosed, painting and other wet work is completed, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels, between 25 percent and 55 percent, during the remainder of the construction period.

E. If woodwork must be stored in areas other than final installation location, store only in areas where environmental conditions comply with these requirements.

1.08 FIELD CONDITIONS

A. During and after installation of custom cabinets, maintain temperature and humidity conditions in building spaces at same levels planned for occupancy.

B. 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.

C. Conditions: Do not install casework until interior concrete work, masonry, plastering and other wet operations are complete.

D. 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 work.
   1. Locate concealed framing, blocking and reinforcements that support woodwork by field measurements before being enclosed.
   2. Where field dimensions cannot be made without delaying the work, project general contractor will guarantee dimensions in order to proceed with manufacturing of woodwork.

1.09 WARRANTY

A. All materials and workmanship covered by this section will carry a five (5) year warranty from date of acceptance.
PART 2 PRODUCTS

2.01 CABINETS
A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.
B. Plastic Laminate Faced Cabinets: Custom grade.
C. Cabinets:
   2. Finish - Exposed Interior Surfaces: Decorative laminate.
   3. Finish - Semi-Exposed Surfaces: Melamine
   4. Finish - Concealed Surfaces: Manufacturer’s option.
   5. Door and Drawer Front Edge Profiles: Square edge with thin applied band.
   6. Cabinet Construction Type: Frameless, flush overlay.

2.02 WOOD-BASED COMPONENTS
A. General:
   1. Wood fabricated from old growth timber is not permitted.
   2. Provide sustainably harvested wood, certified or labeled as specified in Section 01 60 00 - Product Requirements.
B. Core Materials:
   1. Particleboard for Supporting Substrate: ANSI A208.1 Grade 2-M-2, 45 pcf minimum density; minimum 3/4 inch thick; join lengths using metal splines.
C. Adhesives: Chemical resistant waterproof adhesive as recommended by manufacturer of materials being joined.
D. Joint Sealant: Mildew-resistant silicone sealant, white.

2.03 LAMINATE MATERIALS
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Decorative Laminates: GREENGAURD Indoor Air Quality Certified
   1. High-pressure decorative laminate VGS (.028), NEMA Test LD 3-2005.
   2. High-pressure decorative laminate HGS (.048), NEMA Test LD 3-2005.
   3. High-pressure decorative laminate HGP (.039), NEMA Test LD 3-2005.
   5. High-pressure backer BKH (.048), (.039), (.028), NEMA Test LD3-2005.
   6. Thermally fused melamine TFM laminate, NEMA Test LD 3-2005. (TFM allowed on casework interiors only, as specified below. Utilization of TFM on any exterior casework surfaces, including door and drawer faces and finished ends, will not be permitted.)
C. Provide specific types as indicated.
   1. Horizontal Surfaces: HGS, 0.048 inch nominal thickness, color as selected, finish as selected.
   2. Vertical Surfaces: VGS, 0.028 inch nominal thickness, color as selected, finish as selected.
   3. Cabinet Liner: CLS, 0.020 inch nominal thickness, color as selected, finish as selected.
   4. Laminate Backer: BKL, 0.020 inch nominal thickness, undecorated; for application to concealed backside of panels faced with high pressure decorative laminate.
2.04 COUNTERTOPS

A. Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

B. Plastic Laminate Countertops: High-pressure decorative laminate (HPDL) sheet bonded to substrate.
   1. Laminate Sheet: NEMA LD 3, Grade HGS, 0.048 inch nominal thickness.
      a. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
      b. Wear Resistance: In addition to specified grade, comply with NEMA LD 3 High Wear Grade requirements for wear resistance.
      c. Finish: Matte or suede, gloss rating of 5 to 20.
      d. Surface Color and Pattern: As indicated on drawings.
   2. Exposed Edge Treatment: Square, substrate built up to minimum 1-1/2 inch thick; covered with matching laminate.
   3. Back and End Splashes: Same material, same construction.
   4. Substrate: 3/4" particle board with square edge. Provide 4" back splash and side splash. Provide HGS plastic laminate at all exposed surfaces.

2.05 WINDOW SILLS

A. Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.
   1. Flat Sheet Thickness: 1 1/2 inch.
   2. Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.
      a. Manufacturers:
         2) Formica Corporation: www.formica.com/#sle.
         4) Substitutions: See Section 01 60 00 - Product Requirements.
      b. Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.
      c. Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.
      d. Color and Pattern: As indicated on drawings.
   3. Exposed Edge Treatment: Radius edge.
   4. Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.

2.06 ACCESSORIES

A. Adhesive: Type recommended by fabricator to suit application.

B. Plastic Edge Banding: Extruded PVC, flat shaped; smooth finish; self locking serrated tongue; of width to match component thickness.
   1. Color: As selected by Architect from manufacturer's full range.
   2. Use at all exposed plywood edges.

C. Fasteners: Size and type to suit application.

D. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized or chrome-plated finish in concealed locations and stainless steel or chrome-plated finish in exposed locations.

E. Concealed Joint Fasteners: Threaded steel.
F. Grommets: Standard plastic, painted metal, or rubber grommets for cut-outs, in color to match adjacent surface.

2.07 HARDWARE

A. Hardware: BHMA A156.9, types as indicated for quality grade specified.
   1. Finish: Manufacturer's standard, factory-applied powder coat.
   2. Color: Selected by Architect from manufacturer's standard range.
C. Fixed Standard Shelf, Countertop, and Workstation Brackets:
   1. Material: Steel.
   2. Finish: Manufacturer's standard, factory-applied, textured powder coat.
   4. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.
D. Adjustable Shelf Supports: Drilled holes and stainless steel pins for nominal 1 inch spacing adjustments.
E. Drawer and Door Pulls: "U" shaped wire pull, steel with chrome finish, 4 inch centers.
F. Cabinet Locks:
   1. Removable core, disc tumbler, cam style lock with strike.
   2. Elbow catch or chain bolt used to secure inactive door on all locked cabinets.
G. Drawer Slides:
   1. Type: Full extension.
   2. Static Load Capacity: Commercial grade.
   4. Stops: Integral type.
   5. Features: Provide self closing/stay closed type.
   6. Capacity:
H. Hinges: European style concealed self-closing type, steel with polished finish.
I. Coat Rods: 1 inch diameter, 14-gauge chrome plated steel installed in captive mounting hardware.
J. File Suspension System: Extruded molding integral with top of drawer box sides to accept standard hanging file folders.

2.08 FABRICATION - CABINETS

A. Assembly: Shop assemble cabinets for delivery to site in units easily handled and to permit passage through building openings.
B. Edging: Fit shelves, doors, and exposed edges with specified edging. Do not use more than one piece for any single length.
C. Fitting: When necessary to cut and fit on site, provide materials with ample allowance for cutting. Provide matching trim for scribing and site cutting.
D. Plastic Laminate: Apply plastic laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Locate counter butt joints minimum 2 feet from sink cut-outs.
   1. Apply laminate backing sheet to reverse side of plastic laminate finished surfaces.
E. Provide cutouts for plumbing fixtures. Verify locations of cutouts from on-site dimensions. Seal cut edges.
F. 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 of 8 dowels each joint for 39 inch deep cabinets, minimum 6 dowels each joint for 24 inch deep cabinets and a minimum of 4 dowels each joint for 12 inch deep cabinets. (Mechanical or metal hardware fasteners joining cabinet top and bottom panels to the sides will not be accepted.)
      a. Tops, bottoms and sides of all cabinets are Certified particleboard core.
   2. Cabinet backs: 1/4 inch thick medium density fiberboard panel fully captured by the cabinet top, bottom and side panels. Finish to match cabinet interior. 3/4 inch x 4 inch particleboard rails will be placed behind the back panel at the top and bottom, and doweled to the sides utilizing 10mm hardwood fluted dowels. A third intermediate rail will be included on all cabinets taller than 56 inches. Utilize hot melt glue to further secure back and increase overall strength.
      a. Exposed back on fixed or movable cabinets: 3/4 inch thick Certified 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 plywood. Base is 102mm (nominal 4 inch) high unless otherwise indicated on the drawings.
   4. Base units, except sink base units: Full sub-top glued and doweled to cabinet sides. (Mechanical or metal hardware fasteners joining cabinet sub-top panel to the sides will not be accepted.)
      a. 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.
      a. Edging: 3mm ABS/PVC machine applied and machine profiled to 1/8 inch radius.
    7. Adjustable Shelves in Cabinets
       a. Core: Certified Particleboard.
       b. Core Thickness: 3/4 inch up to 36 inches wide, 1 inch over 36 inches wide.
       c. Edge: 3mm ABS/PVC on Front Edge Only.
   8. Interior finish, units with open Interiors:
       a. Top, bottom, back, sides, horizontal and vertical members, and adjustable shelving faces with high-pressure decorative VGS laminate. Use of TFM on exposed open interiors will not be permitted.
   9. Interior finish, units with closed Interiors:
       a. Top, bottom, back, sides, horizontal and vertical members, and adjustable shelving faces with TFM Thermally Fused Melamine laminate.
  10. Exposed ends:
      a. Faced with high-pressure decorative VGS laminate. Use of TFM on exposed ends will not be permitted.
  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.

G. Drawers:
1. Sides, back and sub front: Minimum 1/2 inch thick particleboard, laminated with TFM 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 TFM Thermally Fused Melamine, screwed directly to the bottom edges of drawer box.

H. Door/Drawer Fronts:
1. Core: 3/4 inch thick Certified particleboard.
2. High-pressure decorative VGS laminate exterior, balanced with high-pressure cabinet liner CLS. Use of TFM on exterior or interior surfaces of door/drawer fronts will not be permitted.
3. Edges: 3mm ABS/PVC, machine applied, external edges and outside corners machine profiled to 1/8 inch radius.
4. Provide double doors in opening in excess of 24 inches wide.
5. Provide 2 hinges for each door up to 48 inches in height and 3 hinges for each door over 48 inches in height.

I. Miscellaneous Shelving (not in Cabinets):
1. Core material: 1 inch thick Certified particleboard.
2. High-pressure decorative VGS laminate on both faces.
3. Edges: 3mm ABS/PVC, external edges and outside corners machine profiled to 1/8 inch radius.

2.09 FABRICATION - COUNTERS
A. Fabricate tops and splashes in the largest sections practicable, with top surface of joints flush.
1. Join lengths of tops using best method recommended by manufacturer.
2. Fabricate to overhang fronts and ends of cabinets 1 inch except where top butts against cabinet or wall.
3. Prepare all cutouts accurately to size; replace tops having improperly dimensioned or unnecessary cutouts or fixture holes.

B. Provide back/end splash wherever counter edge abuts vertical surface unless otherwise indicated.
1. Secure to countertop with concealed fasteners and with contact surfaces set in waterproof glue.
2. Apply clear sealant at all seams.
3. Height: 4 inches, unless otherwise indicated.

C. Solid Surfacing: Fabricate tops and wall panels up to 144 inches long in one piece; join pieces with adhesive sealant in accordance with manufacturer’s recommendations and instructions.

PART 3 EXECUTION

3.01 EXAMINATION
A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
C. Verify that wall surfaces have been finished and mechanical and electrical services and outlets are installed in proper locations.
D. Verify adequacy of backing and support framing.
E. Verify location and sizes of utility rough-in associated with work of this section.

3.02 PREPARATION:
A. Condition casework to average prevailing humidity conditions in installation areas prior to installing.
B. Clean surfaces thoroughly prior to installation.
C. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.03 INSTALLATION - CABINETS
A. Install work in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS) requirements for grade indicated.
B. Adjust casework and hardware so that doors and drawers operate smoothly without warp or bind.
C. Set and secure custom cabinets in place, assuring that they are rigid, plumb, and level.
D. Use fixture attachments in concealed locations for wall mounted components.
E. Use concealed joint fasteners to align and secure adjoining cabinet units.
F. Carefully scribe casework abutting other components, with maximum gaps of 1/32 inch. Do not use additional overlay trim for this purpose.
G. Secure cabinets to floor using appropriate angles and anchorages.

3.04 INSTALLATION - COUNTERS
A. Securely attach countertops to cabinets using concealed fasteners. Make flat surfaces level; shim where required.
B. Attach plastic laminate countertops using screws with minimum penetration into substrate board of 5/8 inch.
C. Attach solid surface countertops using compatible adhesive.
D. Seal joint between back/end splashes and vertical surfaces.

3.05 ADJUSTING
A. Adjust moving or operating parts to function smoothly and correctly.

3.06 CLEANING
A. Clean casework, counters, shelves, hardware, fittings, and fixtures.

END OF SECTION
SECTION 07 21 00
THERMAL INSULATION

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Board insulation at cavity wall construction, perimeter foundation wall, and underside of floor slabs.
B. Batt insulation and vapor retarder in exterior wall construction.
C. Batt insulation for filling perimeter window and door shim spaces and crevices in exterior wall and roof.
D. Acoustic Batt insulation. See Section 09 21 16 Gypsum Board Assemblies.

1.02  RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
C. Section 06 10 00 - Rough Carpentry: Supporting construction for batt insulation.
D. Section 07 54 23 - Thermoplastic Membrane Roofing: Installation specified as part of roof system.

1.03  REFERENCE STANDARDS

L. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Underwriters Laboratories Inc..

1.04  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
B. See Section 01 33 00 - Substitution Procedures.
C. Product Data: Provide data on product characteristics, performance criteria, and product limitations.
D. Manufacturer's Installation Instructions: Include information on special environmental conditions required for installation and installation techniques.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.05 FIELD CONDITIONS
A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.

1.06 SEQUENCING
A. Sequence work to ensure fireproofing, firestop, and vapor retarder materials are in place before beginning work of this section.

1.07 COORDINATION
A. Coordinate the work with spray foam closed cell insulation application.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Insulation:
   1. Certainteed
   2. Dow
   3. Owens Corning
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 APPLICATIONS
A. Insulation Under Concrete Slabs: Extruded polystyrene board.
B. Insulation at Perimeter of Foundation: Extruded polystyrene board.
C. Insulation in Metal Framed Walls: Batt insulation with integral vapor retarder.

2.03 FOAM BOARD INSULATION MATERIALS
A. Extruded Polystyrene Board Insulation: ASTM C 578, Type IV; Extruded polystyrene board with natural skin surfaces; with the following characteristics:
   1. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   2. Flame Spread Index: 75 or less, when tested in accordance with ASTM E84.
   3. Smoke Developed Index: 450 or less, when tested in accordance with ASTM E84.
   4. Board Size: 48 x 96 inch or 24 X 96 inch.
   5. Board Thickness: 2 inches.
   6. Board Edges: Square, Shiplap or Tongue and groove.
   7. Thermal Conductivity (k factor) at 75 degrees: or 20.
   10. Water Absorption, maximum: 0.1 percent, volume.

B. Manufacturers:
   1. Dow Chemical Co(Design Basis):
      a. Cavity Wall - "Cavity Mate Plus", type IV
      b. Foundation and slabs - "Styrofoam Highload 40" type VI.
   2. Owens Corning Corp.
      a. Cavity Wall - "Foamular 250", type IV
      b. Foundation and Slabs - "Foamular 400 SE", type VI.
   3. Pactiv Building Products
      a. Cavity Wall - "Green Board Score Board", type IV
      b. Foundation and Slabs - Type VI.
2.04 BATT INSULATION MATERIALS

A. Batt Insulation: ASTM C 665; preformed batt; friction fit, conforming to the following:
   1. Material: Rock or slag fiber, or glass fiber.
   2. Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.
   3. Smoke Developed Index: 50 or less, when tested in accordance with ASTM E84.
   4. Combustibility: Non-combustible, when tested in accordance with ASTM E136.
   5. Formaldehyde Content: Zero.
   6. Thermal Resistance: in accordance with plans.
   7. Thickness: Varies.
   9. Manufacturers:
   10. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

A. Tape: Bright aluminum; Polyethylene or Polyester self-adhering type, mesh reinforced, 2 inch wide.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that substrate, adjacent materials, and insulation materials are dry and that substrates are ready to receive insulation.

B. Verify substrate surfaces are flat, free of irregularities or materials or substances that may impede adhesive bond.

3.02 BOARD INSTALLATION AT FOUNDATION PERIMETER

A. Adhere a 6 inch wide strip of polyethylene sheet over construction, control, and expansion joints with double beads of adhesive each side of joint.
   1. Tape seal joints.
   2. Extend sheet full height of joint.

B. Apply adhesive to back of boards for vertical application:
   1. Three continuous beads per board length.
   2. Full bed 1/8 inch thick.

C. Install boards horizontally on foundation perimeter.
   1. Place boards to maximize adhesive contact.
   2. Install in running bond pattern.
   3. Butt edges and ends tightly to adjacent boards and to protrusions.

D. Extend boards over expansion joints, unbonded to foundation on one side of joint.

E. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

3.03 BOARD INSTALLATION UNDER CONCRETE SLABS

A. Place insulation under slabs on grade after base for slab has been compacted.

B. Cut and fit insulation tightly to protrusions or interruptions to the insulation plane.

C. Prevent insulation from being displaced or damaged while placing vapor retarder and placing slab.
3.04 BATT INSTALLATION

A. Install insulation and vapor retarder in accordance with manufacturer's instructions.
B. Install in exterior cavities at window, door, wall and roof spaces without gaps or voids. Do not compress insulation.
C. Trim insulation neatly to fit spaces. Insulate miscellaneous gaps and voids.
D. Fit insulation tightly in cavities and tightly to exterior side of mechanical and electrical services within the plane of the insulation.
E. Install with factory applied vapor retarder membrane facing warm side of building spaces. Lap ends and side flanges of membrane over framing members.
F. Tape insulation batts in place.
G. Tape seal butt ends, lapped flanges, and tears or cuts in membrane.
H. At metal framing, place vapor retarder on warm side of insulation; lap and seal sheet retarder joints over member face.
I. Tape seal tears or cuts in vapor retarder.
J. Extend vapor retarder tightly to full perimeter of adjacent window and door frames and other items interrupting the plane of the membrane. Tape seal in place.

3.05 PROTECTION

A. Do not permit installed insulation to be damaged prior to its concealment.

END OF SECTION
SECTION 07 21 19
FOAMED-IN-PLACE INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Foamed-in-place insulation.
   1. In exterior framed walls.
   2. In exterior wall crevices.
   3. At junctions of dissimilar wall and roof materials.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS


1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work of this section.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 33 00 - Submittal Procedures.
C. Product Data: Provide product description, insulation properties, overcoat properties, and preparation requirements.
D. Certificates: Certify that products of this section meet or exceed specified requirements.
E. Manufacturer's Installation Instructions: Indicate special procedures, and perimeter conditions requiring special attention.
F. Manufacturer Qualification: Submit documentation of current evaluation of proposed manufacturer and materials.
G. Installer Qualification: Submit documentation of current contractor accreditation and current installer certification. Keep copies of all contractor accreditation and installer certification on site during and after installation. Present on-site documentation upon request.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with not less than ten years of documented experience.
B. Applicator Qualifications: Company specializing in performing work of the type specified, with minimum five years of documented experience.

1.07 FIELD CONDITIONS

A. Do not install insulation when ambient temperature is lower than 70 degrees F.
B. Do not apply foam when temperature is below that specified by the manufacturer for ambient air and substrate.
C. Do not apply foam when temperature is within 5 degrees F of dew point.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Foamed-In-Place Insulation:
   1. BASF Corporation: www.spf.basf.com/#sle.
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS

A. Foamed-In-Place Insulation: Medium-density, rigid, closed cell polyurethane foam; foamed on-site, using blowing agent of water or non-ozone-depleting gas.
   1. Aged Thermal Resistance: R-value of 6.7 (deg F hr sq ft)/Btu, minimum, when tested at 1 inch thickness in accordance with ASTM C518 after aging for 180 days at 41 degrees F.
   2. Water Vapor Permeance: Vapor retarder; 2 perm, maximum, when tested at intended thickness in accordance with ASTM E96/E96M, desiccant method.
   3. Water Absorption: Less than 2 percent by volume, maximum, when tested in accordance with ASTM D2842.
   4. Air Permeance: 0.004 cfm/sq ft, maximum, when tested at intended thickness in accordance with ASTM E2178 or ASTM E283 at 1.5 psf.
   5. Closed Cell Content: At least 90 percent.
   6. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/450, maximum, when tested in accordance with ASTM E84.
   7. Products:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 ACCESSORIES

A. Primer: As required by insulation manufacturer.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify work within construction spaces or crevices is complete prior to insulation application.
B. Verify that surfaces are clean, dry, and free of matter that may inhibit insulation or overcoat adhesion.

3.02 PREPARATION

A. Mask and protect adjacent surfaces from over spray or dusting.
B. Apply primer in accordance with manufacturer's instructions.
3.03 APPLICATION
   A. Apply insulation in accordance with manufacturer’s instructions.
   B. Apply insulation by spray method, to a uniform monolithic density without voids. See drawings for thickness.
   C. Shave insulation to face of metal framing as necessary.
   D. Apply overcoat monolithically, without voids to fully cover foam insulation.
   E. Patch damaged areas.
   F. Where applied to voids and gaps assure space for expansion to avoid pressure on adjacent materials that may bind operable parts.
   G. Trim excess away for applied trim or remove as required for continuous sealant bead.

3.04 PROTECTION
   A. Do not permit subsequent construction work to disturb applied insulation.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A.  Metal roof panel system of preformed steel panels.

1.02  REFERENCE STANDARDS
B.  ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.03  SUBMITTALS
A.  See Section 01 30 00 - Administrative Requirements for submittal procedures.
B.  Product Data:  Manufacturer's data sheets on each product to be used, including:
   1.  Storage and handling requirements and recommendations.
   2.  Installation methods.
   3.  Specimen warranty.
C.  Shop Drawings:  Include layouts of roof panels, details of edge and penetration conditions, spacing and type of connections, flashings, underlayments, and special conditions.
   1.  Show work to be field-fabricated or field-assembled.
D.  Selection Samples:  For each roofing system specified, submit color chips representing manufacturer's full range of available colors and patterns.
E.  Verification Samples:  For each roofing system specified, submit samples of minimum size 12 inches square, representing actual roofing metal, thickness, profile, color, and texture.
F.  Test Reports:  Indicate compliance of metal roofing system to specified requirements.
G.  Warranty:  Submit specified manufacturer's warranty and ensure that forms have been completed in Owner's name and are registered with manufacturer.

1.04  QUALITY ASSURANCE
A.  Manufacturer Qualifications:  Company specializing in manufacturing products specified in this section and with at least ten years of documented experience.
B.  Installer Qualifications:  Company specializing in performing work of the type specified and with at least five years of documented experience.
1.05 DELIVERY, STORAGE, AND HANDLING
   A. Provide strippable plastic protection on prefinished roofing panels for removal after installation.
   B. Store roofing panels on project site as recommended by manufacturer to minimize damage to panels prior to installation.

1.06 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
   B. Finish Warranty: Provide 20-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
   C. Waterproofing Warranty: Provide manufacturer's warranty for weathertightness of roofing system, including agreement to repair or replace roofing that fails to keep out water within specified warranty period of twenty years from Date of Substantial Completion.

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Basis of Design for Metal Roof and Soffit Panels:
      1. 24 ga. Double-Lok w/ minor ribs and high articulating clips w/ thermal spacers, seam spacing to be 24" O.C. by MBCI: www.mbci.com.
   B. Other Architectural Metal Roof Panel Manufacturers:
      3. Substitutions: See Section 01 60 00 - Product Requirements.
   C. Other Metal Soffit Panels Manufacturers:
      3. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PERFORMANCE REQUIREMENTS
   A. Metal Roof Panels: Provide complete roofing assemblies, including roof panels, clips, fasteners, connectors, and miscellaneous accessories, tested for compliance with the following minimum standards:
      1. Structural Design Criteria: Provide panel assemblies designed to safely support design loads at support spacing indicated, with deflection not to exceed L/180 of span length(L) when tested in accordance with ASTM E1592.
      2. Overall: Complete weathertight system tested and approved in accordance with ASTM E1592.
      3. Thermal Movement: Design system to accommodate without deformation anticipated thermal movement over ambient temperature range of 100 degrees F.

2.03 METAL ROOF PANELS
   A. Metal Roof Panels: Provide complete engineered system complying with specified requirements and capable of remaining weathertight while withstanding anticipated movement of substrate and thermally induced movement of roofing system.
   B. Metal Panels: Factory-formed panels with factory-applied finish.
      1. Steel Panels:
         a. Steel Thickness: Minimum 24 gauge, 0.024 inch.
         2. Profile: To match existing.
         3. Texture: Smooth.
         4. Width: Maximum panel coverage of 24 inches.
C. Metal Soffit Panels:
   1. Profile: To match existing.
   2. Material: Precoated steel sheet, 22 gauge, 0.0299 inch minimum thickness.
   3. Color: To match existing.

2.04 ATTACHMENT SYSTEM
A. Concealed System: Provide manufacturer's standard stainless steel or nylon-coated aluminum concealed anchor clips designed for specific roofing system and engineered to meet performance requirements, including anticipated thermal movement.

2.05 SECONDARY FRAMING
A. Miscellaneous Secondary Framing: Light gauge steel framing incidental to structural supports; fabricated from steel sheet.
   1. Profile: Manufacturer's standard cee, zee, asymmetrical zee, hat channel, plain channel, single slope eave strut, double slope eave strut, and angle.
   2. Thickness: 12 gauge, 0.1046 inch.
C. Framing Connectors: Factory-made formed steel sheet, ASTM A653/A653M SS Grade 50, with G60/Z180 hot dipped galvanized coating and factory punched holes.

2.06 FABRICATION
A. Panels: Provide factory or field fabricated panels with applied finish and accessory items, using manufacturer's standard processes as required to achieve specified appearance and performance requirements.

2.07 FINISHES
A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss as selected by Architect from manufacturer’s standard line.
   1. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 ACCESSORIES
A. Miscellaneous Sheet Metal Items: Provide flashings, gutters, downspouts, trim, moldings, closure strips, and caps of the same material, thickness, and finish as used for the roofing panels. Items completely concealed after installation may optionally be made of stainless steel.
   1. Downspouts: To match existing.
   2. Gutters: To match existing.
B. Rib and Ridge Closures: Provide prefabricated, close-fitting components of steel with corrosion resistant finish or combination steel and closed-cell foam.
C. Sealants:
   1. Exposed Sealant: Elastomeric; silicone, polyurethane, or silyl-terminated polyether/polyurethane.
   2. Concealed Sealant: Non-curing butyl sealant or tape sealant.
PART 3 EXECUTION

3.01 EXAMINATION
A. Do not begin installation of preformed metal roof panels until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION
A. Broom clean wood sheathing prior to installation of roofing system.
B. Coordinate roofing work with provisions for roof drainage, flashing, trim, penetrations, and other adjoining work to ensure that completed roof will be free of leaks.
C. Remove protective film from surface of roof panels immediately prior to installation; strip film carefully to avoid damage to prefinished surfaces.
D. Separate dissimilar metals by applying a bituminous coating, self-adhering rubberized asphalt sheet, or other permanent method approved by metal roof panel manufacturer.
E. At locations where metal will be in contact with wood or other absorbent material subject to wetting, seal joints with sealing compound and apply one coat of heavy-bodied bituminous paint.

3.03 INSTALLATION
A. Overall: Install roofing system in accordance with approved shop drawings and metal roof panel manufacturer's instructions and recommendations, as applicable to specific project conditions; securely anchor components of roofing system in place allowing for thermal and structural movement.
   1. Install roofing system with concealed clips and fasteners, except as otherwise recommended by manufacturer for specific circumstances.
   2. Minimize field cutting of panels. Where field cutting is required, use methods that will not distort panel profiles. Use of torches for field cutting is prohibited.
B. Accessories: Install necessary components that are required for complete roofing assembly, including flashings, gutters, downspouts, trim, moldings, closure strips, preformed crickets, caps, equipment curbs, rib closures, ridge closures, and similar roof accessory items.
C. Install roofing felt and building paper slip sheet on roof sheathing before installing preformed metal roof panels; secure by methods acceptable to roof panel manufacturer, minimizing use of metal fasteners; apply from eaves to ridge in shingle fashion, overlapping horizontal joints at least 2 inches and side and end laps at least 3 inches; offset seams in building paper and seams in roofing felt.
D. Roof Panels: Install metal roof panels in accordance with manufacturer's installation instructions, minimizing transverse joints except at junction with penetrations.

3.04 CLEANING
A. Clean exposed sheet metal work at completion of installation. Remove grease and oil films, excess joint sealer, handling marks, and debris from installation, leaving the work clean and unmarked, free from dents, creases, waves, scratch marks, or other damage to the finish.

3.05 PROTECTION
A. Do not permit storage of materials or roof traffic on installed roof panels. Provide temporary walkways or planks as necessary to avoid damage to completed work. Protect roofing until completion of project.
B. Touch-up, repair, or replace damaged roof panels or accessories before Date of Substantial Completion.

END OF SECTION
SECTION 07 42 13
METAL WALL PANELS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Manufactured metal panels for exterior wall panels, with related flashings and accessory components.

1.02 RELATED REQUIREMENTS
A. Section 05 40 00 - Cold-Formed Metal Framing: Wall panel substrate.
B. Section 07 90 05 - Joint Sealers: Sealing joints between metal wall panel system and adjacent construction.

1.03 REFERENCE STANDARDS
D. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

1.04 SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings: Indicate dimensions, layout, joints, construction details, and methods of anchorage.
C. Samples: Submit two samples of wall panel, 12 inch by 12 inch in size illustrating finish color, sheen, and texture.
D. Manufacturer's Qualification Statement.
E. Installer's Qualification Statement.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum twenty years of documented experience.
B. Installer Qualifications: Company specializing in installing products of the type specified in this section with minimum ten years of documented experience.

1.06 MOCK-UP
A. Construct mock-up, minimum ten feet long by six feet high; include panel system, attachments to building frame, associated vapor retarder and air seal materials, weep drainage system, sealants and seals, related insulation in mock-up.
B. Locate where directed by Architect.
C. Mock-up may remain as part of the Work.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Protect panels from accelerated weathering by removing or venting sheet plastic shipping wrap.
B. Store prefinished material off the ground and protected from weather; prevent twisting, bending, or abrasion; provide ventilation; slope metal sheets to ensure proper drainage.
C. Prevent contact with materials that may cause discoloration or staining of products.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Finish Warranty: Provide 5-year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking. Complete forms in Owner's name and register with warrantor.
C. Correct defective work within a five year period after Date of Substantial Completion, including defects in water tightness and integrity of seals.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Basis of Design:
B. Other Acceptable Manufacturers - Metal Wall Panels - Concealed Fasteners:
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MANUFACTURED METAL PANELS
A. Wall Panel System: Factory fabricated prefinished metal panel system, site assembled.
   1. Provide exterior wall panels.
   2. Design and size components to support assembly dead loads, and to withstand live loads caused by positive and negative wind pressure acting normal to plane of wall.
   4. Movement: Accommodate movement within system without damage to components or deterioration of seals, movement between system and perimeter components when subject to seasonal temperature cycling; dynamic loading and release of loads; and deflection of structural support framing.
   5. Air Leakage: Less than 0.01 cfm/sf when tested at 20 psf differential pressure in accordance with ASTM E283.
   6. Water Leakage: No uncontrolled water leakage when tested at 20 psf differential pressure in accordance with ASTM E331.
   7. Drainage: Provide positive drainage to exterior for moisture entering or condensation occurring within panel system.
   8. Fabrication: Formed true to shape, accurate in size, square, and free from distortion or defects; pieces of longest practical lengths.
B. Exterior Wall Panels:
   1. Profile: To match existing.
   2. Side Seams: To match existing.
   3. Material: Precoated steel sheet, 24 gauge, 0.025 inch minimum thickness.
   5. Color: To match existing.

C. Internal and External Corners: Same material, thickness, and finish as exterior sheets; profile to suit system; shop cut and factory mitered to required angles.

D. Expansion Joints: Same material, thickness and finish as exterior sheets; 24 gage, 0.025 inch thick; manufacturer's standard brake formed type, of profile to suit system.

E. Trim: Same material, thickness and finish as exterior sheets; brake formed to required profiles.

F. Anchors: Stainless steel.

2.03 MATERIALS

A. Precoated Steel Sheet: Hot-dipped galvanized steel sheet, ASTM A653/A653M, Structural Steel (SS) or Forming Steel (FS), with G90/Z275 coating; continuous coil-coated on exposed surfaces with specified finish coating and on panel back with specified panel back coating.

2.04 FINISHES

A. Fluoropolymer Coil Coating System: Polyvinylidene fluoride (PVDF) multi-coat superior performing organic coatings system complying with AAMA 2605, including at least 70 percent PVDF resin, and at least 80 percent of coil coated metal surfaces having minimum total dry film thickness (DFT) of 0.9 mil, 0.0009 inch; color and gloss as selected by Architect from manufacturer’s standard line.

1. Products:
   b. Substitutions: See Section 01 60 00 - Product Requirements.

2.05 ACCESSORIES

A. Gaskets: Manufacturer’s standard type suitable for use with system, permanently resilient; ultraviolet and ozone resistant.

B. Concealed Sealants: Non-curing butyl sealant or tape sealant.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that building framing members are ready to receive panels.

3.02 INSTALLATION

A. Install panels on walls in accordance with manufacturer's instructions.

B. Protect surfaces in contact with cementitious materials and dissimilar metals with bituminous paint. Allow to dry prior to installation.

C. Fasten panels to structural supports; aligned, level, and plumb.

D. Locate joints over supports.

E. Use concealed fasteners unless otherwise approved by Architect.

F. Seal and place gaskets to prevent weather penetration. Maintain neat appearance.

3.03 TOLERANCES

A. Maximum Offset From True Alignment Between Adjacent Members Butting or In Line: 1/16 inch.

B. Maximum Variation from Plane or Location Indicated on Drawings: 1/4 inch.

3.04 CLEANING

A. Remove site cuttings from finish surfaces.

B. Remove protective material from wall panel surfaces.
C. See Section 01 74 19 - Construction Waste Management and Disposal, for additional requirements.

D. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

3.05 PROTECTION

A. Protect metal wall panels until completion of project.

B. Touch-up, repair, or replace damaged wall panels or accessories before Date of Substantial Completion.

END OF SECTION
SECTION 07 53 23
EPDM THERMOSET SINGLE-PLY ROOFING - CARLISLE

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Adhered roof system with ethylene propylene diene monomer (EPDM) roofing membrane.
   B. Insulation, flat and tapered.
   C. Deck sheathing.

1.02 RELATED REQUIREMENTS
   A. Section 05 31 00 - Steel Decking.
   B. Section 07 62 00 - Sheet Metal Flashing and Trim: Counterflashing and reglets.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide manufacturer's written information listed below.
      1. Product data indicating membrane materials, flashing materials, insulation, surfacing, and fasteners.
   C. Shop Drawings: Indicate joint or termination detail conditions, conditions of interface with other materials, and paver layout.
   D. Specimen Warranty: For approval.
   E. Warranty:
      1. Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.
      2. Submit installer's certification that installation complies with all warranty conditions for the waterproof membrane.
   F. Manufacturer's Qualification Statement.
   G. Installer's Qualification Statement.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum twenty (20) years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of this section:
      1. Approved by membrane manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Deliver products in manufacturer's original containers, dry, undamaged, with seals and labels intact.
   B. Protect products in weather protected environment, clear of ground and moisture.
   C. Protect foam insulation from direct exposure to sunlight.
   D. Keep Safety Data Sheets (SDS) at the project site at all times during transportation, storage, and installation of materials.
   E. Comply with requirements from Owner to prevent overloading or disturbance of the structure when loading materials onto the roof.

1.06 FIELD CONDITIONS
   A. Do not apply roofing membrane during unsuitable weather. Refer to manufacturer's written instructions.
B. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.

C. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

D. Proceed with work so new roofing materials are not subject to construction traffic as work progresses.

E. Do not allow grease, oil, fats, or other contaminants to come into direct contact with membrane.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Material Warranty: Provide membrane manufacturer's warranty agreeing to replace material that shows manufacturing defects within 10 years after installation.

C. System Warranty: Provide manufacturer's system warranty agreeing to repair or replace roofing that leaks or is damaged due to wind or other natural causes.
   1. Warranty Term: 20 years.
   2. For repair and replacement include costs of both material and labor in warranty.

PART 2 PRODUCTS

2.01 MANUFACTURERS


B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ROOFING APPLICATIONS

A. EPDM Membrane Roofing: One ply membrane, fully adhered, over insulation.

B. Roofing Assembly Performance Requirements and Design Criteria:
   1. Solar Reflectance Index (SRI): Minimum of 64 based on three-year aged value; if three-year aged data is not available, minimum of 82 initial value.
      b. Field applied coating may not be used to achieve specified SRI.
   2. Wind Uplift:
      a. Designed to withstand wind uplift forces calculated with ASCE 7.
   3. Insulation Thermal Resistance (R-Value): Provide R-Value over entire roof deck in accordance with local building code requirements.

2.03 ROOFING MEMBRANE AND ASSOCIATED MATERIALS

A. Single Source Responsibility: Provide and install products from single source. All products in this section shall be Basis of Design.

B. Membrane:
   1. Material: Ethylene propylene diene monomer (EPDM); ASTM D4637/D4637M, Type I (non-reinforced).
   2. Thickness: 60 mil, 0.060 inch, minimum.
   3. Sheet Width: Factory fabricated into largest sheets possible.
   5. Products:
      a. Carlisle SynTec Systems; Sure-Seal.

C. Seaming Materials: As recommended by membrane manufacturer.

D. Membrane Fasteners: As recommended and approved by membrane manufacturer.

E. Flexible Flashing Material: Same material as membrane.
F. Base Flashing: Provide waterproof, fully adhered base flashing system at all penetrations, plane transitions, and terminations.

2.04 DECK SHEATHING AND COVER BOARDS
   A. Cover Board: Cement roof board, complying with ASTM C1325.
      1. Board Size: 48 by 96 inches.
      2. Board Thickness: 1/2 inch.

2.05 INSULATION
   A. Polyisocyanurate (ISO) Board Insulation: ASTM C1289, Type II, Class 1 - Faced with glass fiber reinforced cellulosic felt facers on both major surfaces of the core foam; Grade 1.

2.06 ACCESSORIES
   A. Prefabricated Flashing Accessories:
      1. Corners and Seams: Same material as membrane, in manufacturer's standard thicknesses.
      2. Penetrations: Same material as membrane, with manufacturer's standard cut-outs, rigid inserts, clamping rings, and flanges.
      3. Sealant Pockets: Same material as membrane, with manufacturer's standard accessories, in manufacturer's standard configuration.
      4. Carlisle SynTec Systems; Sure-Seal Pressure-Sensitive Reinforced Universal Securement Strip (RUSS):
   B. Insulation Fasteners: Appropriate for purpose intended and approved by roofing manufacturer.
   C. Membrane Adhesive: As recommended by membrane manufacturer.
   D. Surface Conditioner for Adhesives: Compatible with membrane and adhesives.
   E. Sealants: As recommended by membrane manufacturer.
   F. Cleaner: Manufacturer's standard, clear, solvent-based cleaner.
   G. Edgings and Terminations: Manufacturer's standard edge and termination accessories.
      1. Products: Anchor bar fascia system.
      2. Product: Drip edge.
      3. Products: Coping.
      4. Termination Bar.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces and site conditions are ready to receive work.
   B. Verify deck is supported and secure.
   C. Verify deck is clean and smooth, flat, free of depressions, waves, or projections, properly sloped and suitable for installation of roof system.
   D. Verify deck surfaces are dry and free of snow or ice.
   E. Verify that roof openings, curbs, and penetrations through roof are solidly set, and cant strips are in place.

3.02 PREPARATION, GENERAL
   A. Clean substrate thoroughly prior to roof application.

3.03 METAL DECK PREPARATION
   A. Install deck sheathing on metal deck:
      1. Lay with long side at right angle to flutes; stagger end joints; provide support at ends.
2. Cut sheathing cleanly and accurately at roof breaks and protrusions to provide smooth surface.
3. Tape joints.

B. Mechanically fasten sheathing to roof deck, in accordance with Factory Mutual FM DS 1-28 recommendations and roofing manufacturer's instructions.
   1. Over entire roof area, fasten sheathing using six fasteners with washers per sheathing board.

3.04 INSTALLATION - GENERAL
A. Perform work in accordance with manufacturer's instructions.
B. Do not apply roofing membrane during unsuitable weather.
C. Do not apply roofing membrane when ambient temperature is outside the temperature range recommended by manufacturer.
D. Do not apply roofing membrane to damp or frozen deck surface or when precipitation is expected or occurring.
E. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed the same day.

3.05 INSULATION APPLICATION
A. Attachment of Insulation:
   1. Mechanically fasten insulation to deck in accordance with roofing manufacturer's instructions and Factory Mutual FM DS 1-29 requirements.
B. Lay subsequent layers of insulation with joints staggered minimum 6 inches from joints of preceding layer.
C. On metal deck, place boards parallel to flutes with insulation board edges bearing on deck flutes.
D. Lay boards with edges in moderate contact without forcing, and gap between boards no greater than 1/4 inch. Cut insulation to fit neatly to perimeter blocking and around penetrations through roof.
E. Do not apply more insulation than can be completely waterproofed in the same day.

3.06 MEMBRANE APPLICATION
A. Roll out membrane, free from wrinkles or tears. Place sheet into place without stretching.
B. Shingle joints on sloped substrate in direction of drainage.
C. Fully Adhered Application: Apply adhesive at manufacturer's recommended rate. Fully embed membrane in adhesive except in areas directly over or within 3 inches of expansion joints. Fully adhere one roll before proceeding to adjacent rolls.
D. Overlap edges and ends and seal seams by contact adhesive, minimum 3 inches. Seal permanently waterproof.
E. At intersections with vertical surfaces:
   1. Extend membrane over cant strips and up a minimum of 4 inches onto vertical surfaces.
   2. Fully adhere flexible flashing over membrane and up to nailing strips.
F. Daily Seal: Install daily seal per manufacturer's instructions at the end of each workday. Prevent infiltration of water at incomplete flashings, terminations, and at unfinished membrane edges.

3.07 FIELD QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements for general requirements for field quality control and inspection.
B. Require site attendance of roofing and insulation material manufacturers daily during installation of this work.

3.08 CLEANING
A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
B. Remove wrappings, empty containers, paper, and other debris from the roof daily. Dispose of debris in compliance with local, State, and Federal regulations.
C. Remove bituminous markings from finished surfaces.
D. In areas where finished surfaces are soiled by work of this section, consult manufacturer of surfaces for cleaning advice and conform to their documented instructions.
E. Repair or replace defaced or damaged finishes caused by work of this section.

3.09 PROTECTION
A. Protect installed roofing and flashings from construction operations.
B. Where traffic must continue over finished roof membrane, protect surfaces using durable materials.

END OF SECTION
SECTION 07 62 00
SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fabricated sheet metal items, including flashings, counterflashings, gutters, and downspouts.
   B. Reglets and accessories.
   C. Precast concrete splash pads.

1.02 RELATED REQUIREMENTS
   A. Section 06 10 00 - Rough Carpentry: Wood nailers.
   B. Section 07 90 05 - Joint Sealers.

1.03 REFERENCE STANDARDS
   D. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. See Section 01 33 00 - Submittal Procedures.
   C. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

1.05 QUALITY ASSURANCE
   A. Perform work in accordance with SMACNA Architectural Sheet Metal Manual requirements and standard details, except as otherwise indicated.
   B. Fabricator and Installer Qualifications: Company specializing in sheet metal work with ten years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.
   B. Prevent contact with materials that could cause discoloration or staining.

PART 2 PRODUCTS

2.01 SHEET MATERIALS
   A. Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24-gauge, 0.0239-inch thick base metal, shop pre-coated with PVDF coating.
1. Polyvinylidene Fluoride (PVDF) Coating: Superior performing organic powder coating, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system.

B. Stainless Steel: ASTM A666, Type 304 alloy, soft temper, 28 gauge, (0.0156 inch) thick; smooth No. 4 - Brushed finish.

C. Copper: ASTM B370, cold rolled 16 oz/sq ft, 24 gauge, 0.0216 inch thick; natural finish.

2.02 ACCESSORIES

A. Fasteners: Galvanized steel, with soft neoprene washers.

B. Primer: Zinc chromate type.

C. Protective Backing Paint: Zinc molybdate alkyd.

D. Sealant: Specified in Section 07 90 05.

E. Plastic Cement: ASTM D4586, Type I.

2.03 FABRICATION

A. Form sections true to shape, accurate in size, square, and free from distortion or defects.

B. Form pieces in longest possible lengths.

C. Hem exposed edges on underside 1/2 inch; miter and seam corners.

D. Form material with flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

E. Fabricate corners from one piece with minimum 18 inch long legs; seam for rigidity, seal with sealant.

F. Fabricate vertical faces with bottom edge formed outward 1/4 inch (6 mm) and hemmed to form drip.

2.04 GUTTER AND DOWNSPOUT FABRICATION

A. Gutters: Profile as indicated to match existing.

B. Downspouts: Profile as indicated to match existing.

C. Gutters and Downspouts: Size for rainfall intensity determined by a storm occurrence of 1 in 10 years in accordance with SMACNA (ASMM).

D. Accessories: Profiled to suit gutters and downspouts.

1. Anchorage Devices: In accordance with SMACNA requirements.

2. Gutter Supports: To match existing.

3. Downspout Supports: To match existing.

E. Splash Pads: Precast concrete type, of size and profiles indicated; minimum 3000 psi at 28 days, with minimum 5 percent air entrainment.

F. Seal metal joints.

2.05 EXTERIOR PENETRATION FLASHING PANELS

A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

B. Verify roofing termination and base flashings are in place, sealed, and secure.
3.02 PREPARATION
   A. Install starter and edge strips, and cleats before starting installation.
   B. Install surface mounted reglets true to lines and levels, and seal top of reglets with sealant.
   C. Back paint concealed metal surfaces with protective backing paint to a minimum dry film thickness of 15 mil.

3.03 INSTALLATION
   A. Conform to drawing details.
   B. Insert flashings into reglets to form tight fit. Secure in place with lead wedges. Pack remaining spaces with lead wool. Seal flashings into reglets with sealant.
   C. Secure flashings in place using concealed fasteners. Use exposed fasteners only where permitted.
   D. Apply plastic cement compound between metal flashings and felt flashings.
   E. Fit flashings tight in place. Make corners square, surfaces true and straight in planes, and lines accurate to profiles.
   F. Seal metal joints watertight.
   G. Slope gutters 1/4 inch per 10 feet, minimum.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for field inspection requirements.
   B. Inspection will involve surveillance of work during installation to ascertain compliance with specified requirements.
SECTION 07 84 00
FIRESTOPPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Firestopping systems.
B. Firestopping of all joints and penetrations in fire-resistance rated and smoke-resistant assemblies, whether indicated on drawings or not, and other openings indicated.

1.02 RELATED REQUIREMENTS
A. Section 01 70 00 - Execution and Closeout Requirements: Cutting and patching.
B. Section 09 21 16 - Gypsum Board Assemblies: Gypsum wallboard fireproofing.

1.03 REFERENCE STANDARDS
E. ITS (DIR) - Directory of Listed Products.
F. FM 4991 - Approval Standard of Firestop Contractors.
G. FM P7825 - Approval Guide; Factory Mutual Research Corporation.
H. SCAQMD 1168 - Adhesive and Sealant Applications.
J. UL (FRD) - Fire Resistance Directory.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Schedule of Firestopping: List each type of penetration, fire rating of the penetrated assembly, and firestopping test or design number.
C. Product Data: Provide data on product characteristics, performance ratings, and limitations.
D. Manufacturer's Installation Instructions: Indicate preparation and installation instructions.
E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
F. Certificate from authority having jurisdiction indicating approval of materials used.
G. Qualification statements for installing mechanics.

1.05 QUALITY ASSURANCE
A. Fire Testing: Provide firestopping assemblies of designs that provide the scheduled fire ratings when tested in accordance with methods indicated.
   1. Listing in the current-year classification or certification books of UL, FM, or ITS (Warnock Hersey) will be considered as constituting an acceptable test report.
   2. Valid evaluation report published by ICC Evaluation Service, Inc. (ICC-ES) at www.icc-es.org will be considered as constituting an acceptable test report.
   3. Submission of actual test reports is required for assemblies for which none of the above substantiation exists.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

C. Installer Qualifications: Company specializing in performing the work of this section and:
   1. Approved by Factory Mutual Research under FM Standard 4991, Approval of Firestop Contractors, or meeting any two of the following requirements:
   2. With minimum 5 years documented experience installing work of this type.
   3. Able to show at least 3 satisfactorily completed projects of comparable size and type.
   4. Licensed by authority having jurisdiction.
   5. Approved by firestopping manufacturer.

D. Installing Mechanic's Qualifications: Trained by firestopping manufacturer and able to provide evidence thereof.

1.06 MOCK-UP
A. Install one firestopping assembly representative of each fire rating design required on project.
   1. Where one design may be used for different penetrating items or in different wall constructions, install one assembly for each different combination.
   2. Where firestopping is intended to fill a linear opening, install minimum of 2 linear ft.

B. Obtain approval of authority having jurisdiction before proceeding.

C. If accepted, mock-up will represent minimum standard for the Work.

D. If accepted, mock-up may remain as part of the Work. Remove and replace mock-ups not accepted.

1.07 FIELD CONDITIONS
A. Comply with firestopping manufacturer's recommendations for temperature and conditions during and after installation. Maintain minimum temperature before, during, and for 3 days after installation of materials.

B. Provide ventilation in areas where solvent-cured materials are being installed.

PART 2 PRODUCTS

2.01 FIRESTOPPING - GENERAL REQUIREMENTS
A. Manufacturers:
   2. 3M Fire Protection Products: www.3m.com/firestop.

B. Firestopping Materials with Volatile Content: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.

C. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

2.02 FIRESTOPPING ASSEMBLY REQUIREMENTS
A. Head-of-Wall Firestopping at Joints Between Non-Rated Floor and Fire-Rated Wall: Use any system that has been tested according to ASTM E2837 to have fire resistance F Rating equal to required fire rating of floor or wall, whichever is greater.
   1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.

B. Floor-to-Floor, Wall-to-Wall, and Wall-to-Floor Joints, Except Perimeter, Where Both Are Fire-Rated: Use any system that has been tested according to ASTM E1966 or UL 2079 to
have fire resistance F Rating equal to required fire rating of the assembly in which the joint occurs.

1. Movement: In addition, provide systems that have been tested to show movement capability as indicated.
2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
3. Watertightness: In addition, provide systems that have been tested to show W Rating as indicated.
4. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

C. Through Penetration Firestopping: Use any system that has been tested according to ASTM E814 to have fire resistance F Rating equal to required fire rating of penetrated assembly.

1. Temperature Rise: In addition, provide systems that have been tested to show T Rating as indicated.
2. Air Leakage: In addition, provide systems that have been tested to show L Rating as indicated.
3. Listing by UL, FM, or Intertek in their certification directory will be considered evidence of successful testing.

2.03 FIRESTOPPING FOR FLOOR-TO-FLOOR, WALL-TO-FLOOR, AND WALL-TO-WALL JOINTS

A. Concrete and Concrete Masonry Walls and Floors:

1. Top of Wall Joints at Concrete/Concrete Masonry Wall to Concrete Over Metal Deck Floor:
   a. 2 Hour Construction: UL System HW-D-0181; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
   b. 2 Hour Construction: UL System HW-D-1037; Hilti CFS-SP WB Firestop Joint Spray and CP 672.

2. Concrete/Concrete Masonry Wall to Wall Joints:
   a. 2 Hour Construction: UL System WW-D-0017; Hilti CFS-SP WB Firestop Joint Spray and CP 672.
   b. 2 Hour Construction: UL System WW-D-0032; Hilti CP 606 Flexible Firestop Sealant.

B. Gypsum Board Walls:

1. Wall to Wall Joints:
   a. 2 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.
   b. 1 Hour Construction: UL System WW-D-0067; Hilti CP 606 Flexible Firestop Sealant.

2.04 FIRESTOPPING PENETRATIONS THROUGH CONCRETE AND CONCRETE MASONRY CONSTRUCTION

A. Blank Openings:

1. In Walls:
   a. 2 Hour Construction: UL System C-AJ-0090; Hilti FS-ONE Intumescent Firestop Sealant.

B. Penetrations Through Walls By:

1. Multiple Penetrations in Large Openings:
   a. 2 Hour Construction: UL System C-AJ-8143; Hilti FS-ONE Intumescent Firestop Sealant.

2. Uninsulated Metallic Pipe, Conduit, and Tubing:
   a. 2 Hour Construction: UL System C-AJ-1421; Hilti FS-ONE Intumescent Firestop Sealant or CP 604 Self-Leveling Firestop Sealant.
   b. 2 Hour Construction: UL System C-AJ-1498; Hilti CP 680-P/M Cast-In Device.

3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
a. 2 Hour Construction: UL System C-AJ-2109; Hilti CP 643N/644 Firestop Collar.
b. 2 Hour Construction: UL System C-BJ-2021; Hilti CP 643N Firestop Collar.

4. Electrical Cables Not In Conduit:
a. 2 Hour Construction: UL System C-AJ-3216; Hilti CP 658 Firestop Collar.
b. 2 Hour Construction: UL System W-J-3198; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
c. 2 Hour Construction: UL System W-J-3199; Hilti CFS-SL SK Firestop Sleeve Kit.

5. Cable Trays with Electrical Cables:
a. 3 Hour Construction: UL System C-AJ-4035; Hilti FS-ONE Intumescent Firestop Sealant.
b. 2 Hour Construction: UL System W-J-3060; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
c. 2 Hour Construction: UL System W-J-3143; Hilti CP 658T Firestop Plug.

6. Insulated Pipes:
a. 2 Hour Construction: UL System C-AJ-5048; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, or CP 604 Self-Leveling Firestop Sealant.
b. 2 Hour Construction: UL System W-J-5042; Hilti FS-ONE Intumescent Firestop Sealant.
c. 2 Hour Construction: UL System W-J-5028; Hilti FS-ONE Intumescent Firestop Sealant.

7. HVAC Ducts, Uninsulated:
a. 2 Hour Construction: UL System C-AJ-7111; Hilti FS-ONE Intumescent Firestop Sealant.
b. 2 Hour Construction: UL System C-AJ-7084; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CP 601S Elastomeric Firestop Sealant, or CP 604 Self-Leveling Firestop Sealant.

c. 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE Intumescent Firestop Sealant or CP 606 Flexible Firestop Sealant.

C. Penetrations Through Walls By:
1. Uninsulated Metallic Pipe, Conduit, and Tubing:
a. 2 Hour Construction: UL System W-J-1067; Hilti FS-ONE Intumescent Firestop Sealant.

2. Electrical Cables Not In Conduit:
a. 2 Hour Construction: UL System W-J-3060; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
b. 2 Hour Construction: UL System W-J-3143; Hilti CP 658T Firestop Plug.

3. Insulated Pipes:
a. 2 Hour Construction: UL System W-J-5041; Hilti FS-ONE Intumescent Firestop Sealant.
b. 2 Hour Construction: UL System W-J-5042; Hilti FS-ONE Intumescent Firestop Sealant.
c. 2 Hour Construction: UL System W-J-5028; Hilti FS-ONE Intumescent Firestop Sealant.

4. HVAC Ducts, Uninsulated:
a. 2 Hour Construction: UL System W-J-7109; Hilti FS-ONE Intumescent Firestop Sealant or CP 606 Flexible Firestop Sealant.

5. HVAC Ducts, Insulated:
a. 2 Hour Construction: UL System W-J-7112; Hilti FS-ONE Intumescent Firestop Sealant.

2.05 FIRESTOPPING PENETRATIONS THROUGH GYPSUM BOARD WALLS

A. Blank Openings:
1. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.

B. Penetrations By:
1. Multiple Penetrations in Large Openings:
a. 2 Hour Construction: UL System W-L-1389; Hilti FS-ONE Intumescent Firestop Sealant.
b. 2 Hour Construction: UL System W-L-1408; Hilti FS-ONE Intumescent Firestop Sealant.
c. 2 Hour Construction: UL System W-L-8071; Hilti FS-ONE Intumescent Firestop Sealant.
d. 2 Hour Construction: UL System W-L-8079; Hilti FS-ONE Intumescent Firestop Sealant.
e. 2 Hour Construction: UL System W-L-8087; Hilti FS 657 Fire Block.

2. Uninsulated Metallic Pipe, Conduit, and Tubing:
a. 2 Hour Construction: UL System W-L-1054; Hilti FS-ONE Intumescent Firestop Sealant.
b. 2 Hour Construction: UL System W-L-1164; Hilti FS-ONE Intumescent Firestop Sealant.
c. 2 Hour Construction: UL System W-L-1206; Hilti FS-ONE Intumescent Firestop Sealant.

3. Uninsulated Non-Metallic Pipe, Conduit, and Tubing:
a. 2 Hour Construction: UL System W-L-2078; Hilti CP 643N/644 Firestop Collar.
b. 2 Hour Construction: UL System W-L-2411; Hilti CP 648-E Firestop Wrap Strip.
c. 2 Hour Construction: UL System W-L-2128; Hilti FS-ONE Intumescent Firestop Sealant.

4. Electrical Cables Not In Conduit:
a. 2 Hour Construction: UL System W-L-3065; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, CD 601S Elastomeric Firestop Sealant, or CP 618 Firestop Putty Stick.
b. 2 Hour Construction: UL System W-L-3334; Hilti CP 653 Speed Sleeve.
c. 2 Hour Construction: UL System W-L-3393; Hilti CFS-SL RK Retrofit Sleeve Kit for existing cables.
d. 2 Hour Construction: UL System W-L-3394; Hilti CFS-SL SK Firestop Sleeve Kit.
e. 2 Hour Construction: UL System W-L-3395; Hilti CP653 Speed Sleeve.

5. Cable Trays with Electrical Cables:
a. 2 Hour Construction: UL System W-L-4011; Hilti FS 657 Fire Block.
b. 2 Hour Construction: UL System W-L-4060; Hilti FS-ONE Intumescent Firestop Sealant.

6. Insulated Pipes:
a. 2 Hour Construction: UL System W-L-5028; Hilti FS-ONE Intumescent Firestop Sealant.
b. 2 Hour Construction: UL System W-L-5029; Hilti FS-ONE Intumescent Firestop Sealant.
c. 2 Hour Construction: UL System W-L-5096; Hilti FS-ONE Intumescent Firestop Sealant.
d. 2 Hour Construction: UL System W-L-5257; Hilti FS-ONE Intumescent Firestop Sealant, CP 606 Flexible Firestop Sealant, or CP 601S Elastomeric Firestop Sealant.
e. 2 Hour Construction: UL System W-L-5244; Hilti CP 648-E Firestop Wrap Strip.

7. HVAC Ducts, Insulated:
a. 2 Hour Construction: UL System W-L-7156; Hilti FS-ONE Intumescent Firestop Sealant.

2.06 FIRESTOPPING SYSTEMS

A. Firestopping: Any material meeting requirements. Foam, caulk, putty or manufactured device.

1. Fire Ratings: Use any system listed by UL, FM, or ITS (Warnock Hersey) or that has F Rating equal to fire rating of penetrated assembly and minimum T Rating of 0 and that meets all other specified requirements.
2. Fire Ratings: See Drawings for required systems and ratings.
   B. Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches or less: Any material meeting requirements. Foam, caulk, putty or manufactured device.
   C. Firestopping at Cable Tray Penetrations: Any material meeting requirements. Foam, caulk, putty or manufactured device.
   D. Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Any material meeting requirements. Foam, caulk, putty or manufactured device.
   E. Firestopping at Control and Expansion Joints (without Penetrations): Any material meeting requirements and caulk.

2.07 MATERIALS
   A. Firestopping Sealants: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No.1168.
   B. Elastomeric Silicone Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
   C. Foam Firestopping: Single component silicone foam compound.
   D. Fibered Compound Firestopping: Formulated compound mixed with incombustible non-asbestos fibers.
   E. Fiber Firestopping: Mineral fiber insulation used in conjunction with elastomeric surface sealer forming airtight bond to opening.
   F. Primers, Sleeves, Forms, Insulation, Packing, Stuffing, and Accessories: Type required for tested assembly design.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify openings are ready to receive the work of this section.

3.02 PREPARATION
   A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter that could adversely affect bond of firestopping material.
   B. Remove incompatible materials that could adversely affect bond.
   C. Install backing materials to arrest liquid material leakage.

3.03 INSTALLATION
   A. Install materials in manner described in fire test report and in accordance with manufacturer's instructions, completely closing openings.
   B. Do not cover installed firestopping until inspected by authority having jurisdiction.
   C. Install labeling required by code.

CLEANING

4.01 CLEAN ADJACENT SURFACES OF FIRESTOPPING MATERIALS.

4.02 PROTECTION
   A. Clean adjacent surfaces of firestopping materials.
   B. Protect adjacent surfaces from damage by material installation.

END OF SECTION
SECTION 07 90 05
JOINT SEALERS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Sealants and joint backer rods.
   B. Precompressed foam sealers.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.

1.03 REFERENCE STANDARDS

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordinate the work with other sections referencing this section.

1.05 SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.
   C. Samples: Submit two samples, 2 x 1/2 in size illustrating sealant colors for selection.
   D. Manufacturer’s Installation Instructions: Indicate special procedures, surface preparation, and perimeter conditions requiring special attention.

1.06 QUALITY ASSURANCE
   A. Maintain one copy of each referenced document covering installation requirements on site.
   B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum ten years documented experience.
   C. Applicator Qualifications: Company specializing in performing the work of this section with minimum five years experience.

1.07 MOCK-UP
   A. Construct a mock-up panel of size, detail and configuration indicated on the drawings. Mock-up shall include all components of the exterior wall construction.

1.08 FIELD CONDITIONS
   A. Maintain temperature and humidity recommended by the sealant manufacturer during and after installation.

1.09 COORDINATION
   A. Coordinate the work with all sections referencing this section.

1.10 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective work within a five year period after Date of Substantial Completion.

C. Warranty: Include coverage for installed sealants and accessories which fail to achieve airtight seal, exhibit loss of adhesion or cohesion, or do not cure.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Gunnable and Pourable Sealants:

B. Polyurethane Sealants:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

C. Acrylic Sealants (ASTM C920):
   4. Substitutions: See Section 01 60 00 - Product Requirements.

D. Preformed Compressible Foam Sealers and backer rods:
   2. Emseal Joint Systems, Ltd.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SEALANTS

A. Sealants and Primers - General: Provide products having volatile organic compound (VOC) content as specified in Section 01 61 16.

B. General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, Type OP, Grade NF single component, paintable.
   2. Applications: Use for:
      a. Interior wall and ceiling control joints.
      b. Joints between door and window frames and wall surfaces.
      c. Other interior joints for which no other type of sealant is indicated.
   3. Products:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

C. Silicone Sealant: ASTM C920, Grade NS, Class 25 minimum; Uses NT, A, G, M, O; single component, neutral curing, non-sagging, non-staining, fungus resistant, non-bleeding.
   1. Color: To be selected by Architect from manufacturer's full range.
   3. Service Temperature Range: -65 to 180 degrees F.
5. Products:
   b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 ACCESSORIES
   A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.
   B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.
   C. Joint Backing: Round foam rod compatible with sealant; ASTM D 1667, closed cell PVC; oversized 30 to 50 percent larger than joint width.
   D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer to suit application.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that substrate surfaces and joint openings are ready to receive work.
   B. Verify that joint backing and release tapes are compatible with sealant.

3.02 PREPARATION
   A. Remove loose materials and foreign matter that could impair adhesion of sealant.
   B. Clean and prime joints in accordance with manufacturer's instructions.
   C. Perform preparation in accordance with manufacturer's instructions and ASTM C1193.
   D. Protect elements surrounding the work of this section from damage or disfigurement.

3.03 INSTALLATION
   A. Perform work in accordance with sealant manufacturer's requirements for preparation of surfaces and material installation instructions.
   B. Perform installation in accordance with ASTM C1193.
   C. Install bond breaker where joint backing is not used.
   D. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.
   E. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
   F. Tool joints concave.

3.04 CLEANING
   A. Clean adjacent soiled surfaces.

3.05 PROTECTION
   A. Protect sealants until cured.

END OF SECTION
SECTION 08 11 13
HOLLOW METAL DOORS AND FRAMES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Non-fire-rated steel door frames.
B. Non-fire-rated steel doors.
C. Steel frames for wood doors.
D. Fire-rated wood doors and steel frames.

1.02 RELATED REQUIREMENTS
A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
C. Section 08 71 00 - Door Hardware.
D. Section 08 80 00 - Glazing: Glass for doors and borrowed lites.
E. Section 09 90 00 - Painting and Coating: Field painting.

1.03 REFERENCE STANDARDS
B. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames and Frame Anchors.
C. ANSI/SDI A250.8 - Specifications for Standard Steel Doors and Frames (SDI-100).
D. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
F. BHMA A156.115 - Hardware Preparation in Steel Doors and Steel Frames.
G. DHI A115 Series - Specifications for Steel Doors and Frame Preparation for Hardware; Door and Hardware Institute (ANSI/DHI A115 Series).
J. UL 752 - Standard for Bullet-Resisting Equipment.

1.04 SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements for submittal procedures.
B. Product Data: Materials and details of design and construction, hardware locations, reinforcement type and locations, anchorage and fastening methods, and finishes; and one copy of referenced grade standard.
C. Shop Drawings: Details of each opening, showing elevations, glazing, frame profiles, and identifying location of different finishes, if any.
D. Samples: Submit two samples of metal, 2 x 2 inches in size showing factory finishes, colors, and surface texture.
E. Installation Instructions: Manufacturer's published instructions, including any special installation instructions relating to this project.

F. Manufacturer's Certificate: Certification that products meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.

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

C. Maintain at the project site a copy of all reference standards dealing with installation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Store in accordance with NAAMM HMMA 840.

B. Protect with resilient packaging; avoid humidity build-up under coverings; prevent corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Steel Door Frames:
   5. Phillip Manufacturing Company
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOORS AND FRAMES

A. Requirements for All Door Frames:
   2. Finish: Factory primed, for field finishing.

2.03 STEEL DOORS

A. Exterior Doors:
   1. Grade: ANSI A250.8 Level 3, physical performance Level A, Model 1, full flush.
      a. Level 3 - Extra Heavy-duty.
      b. Physical Performance Level A, 1,000,000 cycles; in accordance with ANSI/SDI A250.4.
      c. Model 1 - Full Flush.
      d. Door Face Metal Thickness: 16 gauge, 0.053 inch, minimum.
      e. Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
   2. Core: Polyurethane.
   3. Top Closures for Outswinging Doors: Flush with top of faces and edges.
   4. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.
   5. Texture: Smooth faces.
   6. Weatherstripping: Separate, see Section 08 71 00.
   7. Finish: Factory primed, for field finishing.

2.04 STEEL FRAMES

A. General:
   1. Comply with the requirements of grade specified for corresponding door.
   2. Finish: Factory primed, for field finishing.
3. Frames Wider than 48 Inches: Reinforce with steel channel fitted tightly into frame head, flush with top.

B. Exterior Door Frames: Fully welded.
1. Galvanizing: All components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A60/ZF180 coating.
2. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
3. Finish: Factory primed, for field finishing.
4. Weatherstripping: Integral, recessed into door edge or frame.

C. Interior Door Frames, Non-Fire-Rated: Fully welded type.
1. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
2. Finish: Factory primed, for field finishing.

D. Interior Door Frames, Fire-Rated: Full profile/continuously welded type.
1. Fire Rating: Same as door, labeled.
2. Frame Metal Thickness: 16 gage, 0.053 inch, minimum.
3. Finish: Factory primed, for field finishing.

E. Frames for Wood Doors: Comply with frame requirements in accordance with corresponding door.

F. Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

G. Provide mortar guard boxes for hardware cut-outs in frames to be installed in masonry or to be grouted.

H. Frames in Masonry Walls: Size to suit masonry coursing with head member 4 inch high to fill opening without cutting masonry units.

2.05 FINISHES
A. Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.
B. Bituminous Coating: Cold-applied asphalt mastic, compounded for 15 mil, 0.015 inch dry film thickness (DFT) per coat; provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
1. Fire-Rated Frames: Comply with fire rating requirements indicated.

2.06 ACCESSORY MATERIALS
A. Glazing: As specified in Section 08 80 00, factory installed.
B. Silencers: Resilient rubber or vinyl, fitted into drilled hole; 3 on strike side of single door, 3 on center mullion of pairs, and 2 on head of pairs without center mullions.
C. Temporary Frame Spreaders: Provide for all factory- or shop-assembled frames.

2.07 FINISH MATERIALS
A. Primer: Rust-inhibiting, complying with ANSI A250.10, door manufacturer's standard, baked on.
B. Bituminous Coating: Asphalt emulsion or other high-build, water-resistant, resilient coating.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.
C. Verify that finished walls are in plane to ensure proper door alignment.
3.02 INSTALLATION
   A. Coordinate frame anchor placement with wall construction.
   B. Coordinate installation of hardware.
   C. Touch up damaged factory finishes.

3.03 TOLERANCES
   A. Maximum Diagonal Distortion: 1/16 in measured with straight edge, corner to corner.

3.04 ADJUSTING
   A. Adjust for smooth and balanced door movement.

3.05 SCHEDULE - SEE DRAWINGS

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Flush wood doors; flush and flush glazed configuration; fire rated and non-rated.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of
      removed materials; requirements for recycling.
   C. Section 08 11 13 - Hollow Metal Doors and Frames.
   D. Section 08 80 00 - Glazing.

1.03 REFERENCE STANDARDS
   A. ANSI A135.4 - Basic Hardboard.
   C. UBC Std 7-2, Part II - Test Standard for Smoke- and Draft-control Assemblies; International
      Conference of Building Officials; 1997.
   D. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
   E. WDMA I.S. 1A - Interior Architectural Wood Flush Doors.

1.04 SUBMITTALS
   A. See Section 01 33 00 - Submittal Procedures for submittal procedures.
   B. Product Data: Indicate door core materials and construction; veneer species, type and
      characteristics.
   C. Shop Drawings: Show doors and frames, elevations, sizes, types, swings, undercuts, beveling,
      blocking for hardware, factory machining, factory finishing, cutouts for glazing and other details.
   D. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts
      required, special beveling, special blocking for hardware, factory machining criteria, factory
      finishing criteria, identify cutouts for glazing.
   E. Samples: Submit two samples of door construction, 8 x 12 inch in size cut from top; or bottom
      corner of door.
   F. Samples: Submit two samples of door veneer, 6 x 6 inch in size illustrating wood grain, stain
      color, and sheen.
   G. Manufacturer's Installation Instructions: Indicate special installation instructions.
   H. Warranty, executed in Owner's name.

1.05 QUALITY ASSURANCE
   A. Maintain one copy of the specified door quality standard on site for review during installation
      and finishing.
   B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in
      this section with minimum ten years of documented experience.
   C. Installer Qualifications: Company specializing in performing work of the type specified in this
      section, with not less than five years of documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Package, deliver and store doors in accordance with specified quality standard.
B. Accept doors on site in manufacturer's packaging. Inspect for damage.

C. Protect doors with resilient packaging sealed with heat shrunk plastic. Do not store in damp or wet areas; or in areas where sunlight might bleach veneer. Seal top and bottom edges with tinted sealer if stored more than one week. Break seal on site to permit ventilation.

1.07 PROJECT CONDITIONS
A. Coordinate the work with door opening construction, door frame and door hardware installation.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
B. Interior Doors: Provide manufacturer's warranty for the life of the installation.
C. Provide warranty for the following term:
   1. Interior Doors: Warranty - Provide for replacing, including cost of rehanging and refinishing, at no cost to Owner, wood doors exhibiting defects in materials or workmanship including warp and delaminating for the life of installation.
D. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Wood Veneer Faced Doors:
   3. VT Industries www.VTindustries.com
   5. Oshkosh: www.oshkosh.com
   6. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 DOORS
A. All Doors: See drawings for locations and additional requirements.
   1. Quality Level: Custom Grade, Extra Heavy Duty performance, in accordance with WDMA I.S.1-A.
   2. Wood Veneer Faced Doors: 5-ply unless otherwise indicated.
   3. Classroom Doors STC 30

B. Interior Doors: 1-3/4 inches; thick unless otherwise indicated; flush construction.
   1. Fire Rated Doors: Tested to ratings indicated on drawings in accordance with International Building Code ("positive pressure"); UL or WH (ITS) labeled without any visible seals when door is open.
   2. Wood veneer facing with factory transparent finish.

2.03 DOOR AND PANEL CORES
A. Non-Rated Solid Core and 20 Minute Rated Doors: Type structural composite lumber core (SCLC), plies and faces as indicated above.
B. Fire Rated Doors: Mineral core, Type FD, plies and faces as indicated above; with core blocking as required to provide adequate anchorage of hardware without through-bolting.
C. Sound Resistant Doors: Equivalent to type, with particleboard core (PC) construction with core as required to achieve STC rating specified; plies and faces as indicated above.

2.04 DOOR FACINGS
1. Cut: Plain Sliced.
2. Veneer match: Book match and balanced.
3. Vertical Edges: Same species as face veneer.

B. Facing Adhesive: Type II - water resistant.

2.05 ACCESSORIES

A. Glazing Stops: Wood, of same species as door facing, butted; or mitered corners; prepared for countersink style tamper proof screws.

2.06 DOOR CONSTRUCTION

A. Fabricate doors in accordance with door quality standard specified.
B. Cores Constructed with stiles and rails:
   1. Provide solid blocks at lock edge for hardware reinforcement.
   2. Provide solid blocking for other through bolted hardware.
C. Fit door edge trim to edge of stiles after applying veneer facing.
D. Factory machine doors for hardware other than surface-mounted hardware, in accordance with hardware requirements and dimensions.
E. Factory fit doors for frame opening dimensions identified on shop drawings, with edge clearances in accordance with specified quality standard.
F. Provide edge clearances in accordance with the quality standard specified.

2.07 FACTORY FINISHING - WOOD VENEER DOORS

A. Factory finish doors in accordance with specified quality standard:
   1. Transparent Finish: Transparent catalyzed polyurethane, Custom quality, semi-gloss sheen.
B. Factory finish doors in accordance with approved sample.
C. Seal door top edge with color sealer to match door facing.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify existing conditions before starting work.
B. Verify that opening sizes and tolerances are acceptable.
C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.02 INSTALLATION

A. Install doors in accordance with manufacturer's instructions and specified quality standard.
B. Factory-Finished Doors: Do not field cut or trim; if fit or clearance is not correct, replace door.
C. Use machine tools to cut or drill for hardware.
D. Coordinate installation of doors with installation of frames and hardware.
E. Coordinate installation of glazing.

3.03 TOLERANCES

A. Conform to specified quality standard for fit and clearance tolerances.
B. Conform to specified quality standard for telegraphing, warp, and squareness.
C. Maximum Diagonal Distortion (Warp): 1/8 inch measured with straight edge or taut string, corner to corner, over an imaginary 36 by 84 inches surface area.
D. Maximum Vertical Distortion (Bow): 1/8 inch measured with straight edge or taut string, top to bottom, over an imaginary 36 by 84 inches surface area.

E. Maximum Width Distortion (Cup): 1/8 inch measured with straight edge or taut string, edge to edge, over an imaginary 36 by 84 inches surface area.

3.04 ADJUSTING

A. Adjust doors for smooth and balanced door movement.

B. Adjust closers for full closure.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
A. Wall access door and frame units.
B. Ceiling access door and frame units.

1.02 RELATED REQUIREMENTS
A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 78 39 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
C. Section 09 90 00 - Painting and Coating: Field paint finish.

1.03 REFERENCE STANDARDS
A. ITS (DIR) - Directory of Listed Products.
B. UL (FRD) - Fire Resistance Directory.

1.04 SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified and with at least five years documented experience.

PART 2 PRODUCTS

2.01 ACCESS DOOR AND PANEL APPLICATIONS
A. Walls, Unless Otherwise Indicated:
   1. Material: Steel.
   2. Size: 18 x18 inches, unless otherwise indicated.
   4. Tool-operated spring or cam lock; no handle.
   5. In All Wall Types: Surface mounted face frame and door surface flush with frame surface.
   6. In Gypsum Board: Drywall bead frame with door surface flush with wall surface.
   8. In Masonry: Surface mounted frame with door surface flush with frame surface.
B. Walls in Wet Areas:
   1. Material: Steel, hot-dipped galvanized.
   2. Size: 18 x18 inches, unless otherwise indicated.
   4. Tool-operated spring or cam lock; no handle.
   5. In All Wall Types: Surface mounted face frame and door surface flush with frame surface.
   6. In Gypsum Board: Drywall bead frame with door surface flush with wall surface.
   8. In Masonry: Surface mounted frame with door surface flush with frame surface.
C. Fire Rated Walls: See drawings for wall fire ratings.
   1. Material: Steel.
2. Size: 18 x 18 inches, unless otherwise indicated.
3. Insulated, double skin door panel.
4. Tool-operated spring or cam lock; no handle.

D. Ceilings, Unless Otherwise Indicated: Same type as for walls.
1. Material: Steel.
2. Size in Lay-in Grid Ceilings: To match grid module.
3. Size in Other Ceilings: 18 x 18 inches, unless otherwise indicated.
4. Standard duty, hinged door.
5. Tool-operated spring or cam lock; no handle.

E. Fire Rated Ceilings: See drawings for ceiling fire ratings.
1. Material: Steel.
2. Size: 18 x 18 inches, unless otherwise indicated.
4. Tool-operated spring or cam lock; no handle.

2.02 WALL AND CEILING UNITS

A. Manufacturers:

B. Access Doors: Factory fabricated door and frame units, fully assembled units with corner joints welded, filled, and ground flush; square and without rack or warp; coordinate requirements with assemblies units are to be installed in.
1. Door Style: Single thickness with rolled or turned in edges.
2. Double-Skinned Hollow Steel Door Panels: 16 gage, 0.059 inch, minimum, on both sides and all edges.
3. Units in Fire Rated Assemblies: Fire rating as required by applicable code for the fire rated assembly in which they are to be installed.
5. Primed Finish: Polyester powder coat; manufacturer's standard color.
6. Hardware:
   a. Hardware for Fire Rated Units: As required for listing.
   b. Hinges for Non-Fire-Rated Units: Concealed, constant force closure spring type.
   c. Handle: Fixed.
   d. Latch/Lock: Tamperproof tool-operated cam latch.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that rough openings are correctly sized and located.

3.02 INSTALLATION

A. Install units in accordance with manufacturer's instructions.
B. Install frames plumb and level in openings. Secure rigidly in place.
C. Position units to provide convenient access to the concealed work requiring access.

END OF SECTION
SECTION 08 43 13
ALUMINUM-FRAMED STOREFRONTS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Aluminum-framed storefront, with insulating glass units.

1.02 RELATED REQUIREMENTS
A. Section 08 80 00 - Glazing: Glass and glazing accessories.

1.03 REFERENCE STANDARDS
A. AAMA CW-10 - Care and Handling of Architectural Aluminum from Shop to Site.
B. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordinate with installation of other components that comprise the exterior enclosure.
B. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide component dimensions, describe components within assembly, anchorage and fasteners, glass and infill, internal drainage details.
C. Shop Drawings: Indicate system dimensions, framed opening requirements and tolerances, affected related Work, expansion and contraction joint location and details, and field welding required.
D. Manufacturer's Certificate: Certify that the products supplied meet or exceed the specified requirements.
E. Design Data: Provide framing member structural and physical characteristics, engineering calculations, and dimensional limitations.
F. Manufacturer Qualifications Statement.
G. Installer Qualifications Statement.
H. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing aluminum glazing systems with minimum 20 years of documented experience.
B. Installer Qualifications: Company specializing in performing work of type specified and with at least 10 years of documented experience and approved by manufacturer.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Handle products of this section in accordance with AAMA CW-10.
   B. Protect finished aluminum surfaces with wrapping. Do not use adhesive papers or sprayed coatings that bond to aluminum when exposed to sunlight or weather.

1.08 FIELD CONDITIONS
   A. Do not install sealants when ambient temperature is less than 40 degrees F. Maintain this minimum temperature during and 48 hours after installation.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a five year period after Date of Substantial Completion.
   C. Provide five year manufacturer warranty against failure of glass seal on insulating glass units, including interpane dusting or misting. Include provision for replacement of failed units.
   D. Provide five year manufacturer warranty against excessive degradation of exterior finish. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 PRODUCTS
2.01 BASIS OF DESIGN -- FRAMING FOR INSULATING GLAZING
   A. Front-Set Style, Thermally-Broken:
      1. Basis of Design: Kawneer TriFab VG 451T.
      2. Vertical Mullion Dimensions: 2 inches wide by 4-1/2 inches deep.
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MANUFACTURERS
   A. Aluminum-Framed Storefront:
      1. EFCO Corporation: www.efcocorp.com/#sle.
      5. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 STOREFRONT
   A. Aluminum-Framed Storefront: Factory fabricated, factory finished aluminum framing members with infill, and related flashings, anchorage and attachment devices.
      1. Finish: Class I natural anodized.
         a. Factory finish all surfaces that will be exposed in completed assemblies.
         b. Coat concealed metal surfaces that will be in contact with cementitious materials or dissimilar metals with bituminous paint.
      2. Finish Color: As selected from manufacturer’s standards.
      3. Fabrication: Joints and corners flush, hairline, and weatherproof, accurately fitted and secured; prepared to receive anchors and hardware; fasteners and attachments concealed from view; reinforced as required for imposed loads.
      5. System Internal Drainage: Drain to the exterior by means of a weep drainage network any water entering joints, condensation occurring in glazing channel, and migrating moisture occurring within system.
      6. Expansion/Contraction: Provide for expansion and contraction within system components caused by cycling temperature range of 170 degrees F over a 12 hour period without
causing detrimental effect to system components, anchorages, and other building elements.

7. Movement: Allow for movement between storefront and adjacent construction, without damage to components or deterioration of seals.

8. Perimeter Clearance: Minimize space between framing members and adjacent construction while allowing expected movement.

B. Structural Performance Requirements: Design and size components to withstand the following load requirements without damage or permanent set.
   1. Design Wind Loads: Comply with the requirements of IBC 2018 code.

C. Performance Requirements
   1. Wind Loads: Design and size components to withstand the specified load requirements without damage or permanent set, when tested in accordance with ASTM E330/E330M, using loads 1.5 times the design wind loads and 10 second duration of maximum load.
      a. Member Deflection: Limit member deflection to flexure limit of glass in any direction, with full recovery of glazing materials.
   2. Air Leakage: 0.06 cfm/sq ft maximum leakage of storefront wall area when tested in accordance with ASTM E283/E283M at 1.57 psf pressure difference.

2.04 COMPONENTS
   A. Aluminum Framing Members: Tubular aluminum sections, thermally broken with interior section insulated from exterior, drainage holes and internal weep drainage system.
   B. Glazing: As specified in Section 08 80 00.

2.05 MATERIALS
   B. Fasteners: Stainless steel.
   C. Perimeter Sealant: As specified in Section 07 90 05.
   D. Glazing Gaskets: Type to suit application to achieve weather, moisture, and air infiltration requirements.

2.06 FINISHES
   A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils thick.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify dimensions, tolerances, and method of attachment with other work.
   B. Verify that wall openings and adjoining air and vapor seal materials are ready to receive work of this section.

3.02 INSTALLATION
   A. Install wall system in accordance with manufacturer's instructions.
   B. Attach to structure to permit sufficient adjustment to accommodate construction tolerances and other irregularities.
   C. Provide alignment attachments and shims to permanently fasten system to building structure.
   D. Align assembly plumb and level, free of warp or twist. Maintain assembly dimensional tolerances, aligning with adjacent work.
   E. Provide thermal isolation where components penetrate or disrupt building insulation.
F. Install sill flashings. Turn up ends and edges; seal to adjacent work to form water tight dam.
G. Where fasteners penetrate sill flashings, make watertight by seating and sealing fastener heads to sill flashing.
H. Coordinate attachment and seal of perimeter air and vapor barrier materials.
I. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.
J. Set thresholds in bed of mastic and secure.
K. Install glass and infill panels in accordance with Section 08 80 00, using glazing method required to achieve performance criteria.
L. Install perimeter sealant in accordance with Section 07 90 05.
M. Touch-up minor damage to factory applied finish; replace components that cannot be satisfactorily repaired.

3.03 TOLERANCES
A. Maximum Variation from Plumb: 0.06 inches every 3 ft non-cumulative or 1/16 inches per 10 ft, whichever is less.
B. Maximum Misalignment of Two Adjoining Members Abutting in Plane: 1/32 inch.

3.04 CLEANING
A. Remove protective material from pre-finished aluminum surfaces.
B. Wash down surfaces with a solution of mild detergent in warm water, applied with soft, clean wiping cloths. Take care to remove dirt from corners. Wipe surfaces clean.
C. Remove excess sealant by method acceptable to sealant manufacturer.

3.05 PROTECTION
A. Protect installed products from damage during subsequent construction.

END OF SECTION
SECTION 08 80 00
GLAZING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Glass.
B. Plastic glazing film.
C. Glazing compounds and accessories.

1.02 RELATED REQUIREMENTS
A. Section 07 90 05 - Joint Sealers: Sealant and back-up material.
B. Section 08 11 13 - Hollow Metal Doors and Frames: Glazed lites in doors and borrowed lites.
C. Section 08 14 16 - Flush Wood Doors: Glazed lites in doors.
D. Section 08 43 13 - Aluminum-Framed Storefronts: Glazing furnished by storefront manufacturer.

1.03 REFERENCE STANDARDS
F. ASTM C1499-09 - Monotonic Equibiaxial Flexural Strength of Glass (Double Ring Test).
H. STM D1044 - Test method for Resistance of Transparent Plastics to Surface Abrasion.
P. GANA (GM) - GANA Glazing Manual.
Q. GANA (SM) - GANA Sealant Manual.
U. National Institute of Justice Standard NIJ-STD-0108.01.
1.04 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.

1.05 SUBMITTALS
   A. See Section 01 33 00 - Submittal Procedures.
   B. Product Data on Glass Types: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
   C. Samples for Initial Selection: Submit 6 x 6 inch samples of tinted and coated glass for initial selection of materials to match existing glazing.
   D. Samples: Submit two samples 6 x 6 inch in size of glass units, showing coloration and design.
   E. Certificates: Certify that products meet or exceed specified requirements.

1.06 QUALITY ASSURANCE
   B. Manufacturer Qualifications: Company specializing in performing the work of this section with minimum twenty years documented experience.
   C. Installer Qualifications: Company specializing in performing the work of this section with minimum ten years documented experience.

1.07 MOCK-UP
   A. See Section 01 40 00 - Quality Requirements, for additional mock-up requirements.
   B. Construct a mock-up panel of size, detail and configuration indicated on the drawings. Mock-up shall include all components of the exterior wall construction.

1.08 FIELD CONDITIONS
   A. Do not install glazing when ambient temperature is less than 50 degrees F.
   B. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Sealed Insulating Glass Units: Provide a five (5) year warranty to include coverage for seal failure, interpane dusting or misting, including replacement of failed units.
   C. Laminated Glass: Provide a five (5) year warranty to include coverage for delamination, including replacement of failed units.
   D. Bullet Resistant Film: Manufacturer's standard warranty agreeing to replace films that fail within 10 years from date of substantial completion.

1.10 PERFORMANCE REQUIREMENTS
   A. General: Provide glass capable of withstanding thermal movement and wind and impact loads (where applicable) as specified in paragraph B following.
   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. Basic Wind Speed: 120 mph.

C. Thermal Movements: Provide glazing that allows for thermal movements resulting from ambient and surface temperatures changes acting on glass framing members and glazing components.

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 1/4 inch (6.0 mm) thick.
   2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
   3. 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. per h per degree F.

PART 2 PRODUCTS

2.01 BASIS OF DESIGN - STANDARD INSULATING AND NON-INSULATING GLASS UNITS

A. Type G1 - Sealed Insulating Glass Units: Vision glazing, low-E.
   1. Application(s): All exterior glazing unless otherwise indicated.
   2. Substitutions: Refer to Section 01 60 00 - Product Requirements.
   3. Overall Unit Thickness 1", each lite 1/4"
   4. Between-lite space filled with argon.
   5. Tint: Clear.
   8. Total Visible Light Transmittance: 45 percent.
   10. Outboard Lite: Fully tempered float glass, 1/4 inch thick, minimum.
      a. Coating: SunGuard SNX 62/27 on #2 surface.
      b. Tint: Clear.

B. Type G2 - Single Vision Glazing:
   1. Applications: All interior glazing unless otherwise indicated.
   2. Type: Fully tempered float glass.
   3. Tint: Clear.
   4. Thickness: 1/4 inch.

C. Type G3 - Fire-Rated Safety Glazing:
   1. Applications: Provide this type of glazing in the following locations:
      a. Glazed lites in fire doors.
      b. Sidelights, borrow lites, and other glazed openings in partitions indicated as having an hourly fire rating.
      c. Other locations indicated on the drawings.
   2. Fire Rating: As indicated on the drawings.
   3. Type: As required by manufacturer to achieve fire rating.
   4. Thickness: As required by manufacturer to achieve fire rating.

2.02 GLASS MATERIALS

A. Float Glass Manufacturers:
4. Substitutions: Refer to Section 01 60 00 - Product Requirements.

B. Float Glass: All glazing is to be float glass unless otherwise indicated.
2. Tinted Types: Color and performance characteristics as indicated.
3. Thicknesses: As indicated; for exterior glazing comply with specified requirements for wind load design regardless of specified thickness.

C. Fire Resistance-Rated Glazing: Type, thickness, and configuration as required to achieve indicated ratings.
1. IBC Fire Resistance Rating: As indicated on drawings.
2. Safety Certification: 16 CFR 1201 Category II.
3. Products:
   b. SAFTI FIRST, a division of O'Keeffe's Inc; SuperClear 45-HS:  www.safti.com.
   c. SAFTI FIRST, a division of O'Keeffe's Inc; SuperLite II-XL:  www.safti.com.
   d. Substitutions: Refer to Section 01 60 00 - Product Requirements.

2.03 SEALED INSULATING GLASS UNITS
A. Manufacturers:
1. Any of the manufacturers specified for float glass.
2. Substitutions: Refer to Section 01 60 00 - Product Requirements.

B. Sealed Insulating Glass Units: Types as indicated.
1. Durability: Certified by an independent testing agency to comply with ASTM E2190.
2. Edge Spacers: Aluminum, bent and soldered corners.
3. Edge Seal: Glass to elastomer with supplementary silicone sealant.
4. Purge interpane space with dry hermetic air.

2.04 GLAZING ACCESSORIES
A. Setting Blocks: Neoprene, 80 to 90 Shore A durometer hardness, ASTM C864 Option I. Length of 0.1 inch for each square foot of glazing or minimum 4 inch x width of glazing rabbet space minus 1/16 inch x height to suit glazing method and pane weight and area.

B. Spacer Shims: Neoprene, 50 to 60 Shore A durometer hardness, ASTM C 864 Option I. Minimum 3 inch long x one half the height of the glazing stop x thickness to suit application, self adhesive on one face.

C. Glazing Tape: Preformed butyl compound with integral resilient tube spacing device; 10 to 15 Shore A durometer hardness; coiled on release paper; black color.
1. Manufacturers:
   b. Substitutions: Refer to Section 01 60 00 - Product Requirements.

D. Glazing Gaskets: Resilient silicone extruded shape to suit glazing channel retaining slot; ASTM C864 Option I; black color.

E. Glazing Clips: Manufacturer's standard type.

2.05 PLASTIC FILMS
A. Manufacturers:
1. 3M Window Film:  www.3m.com/US/arch_construct/scpd/windowfilm.
2. Decorative Films:  www.decorativefilm.com
4. Substitutions: Refer to Section 01 60 00 - Product Requirements.

B. Plastic Film Types

C. Schedule:
   1. See drawings for plastic films application locations.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that openings for glazing are correctly sized and within tolerance.
   B. Verify that surfaces of glazing channels or recesses are clean, free of obstructions that may impede moisture movement, weeps are clear, and ready to receive glazing.

3.02 PREPARATION
   A. Clean contact surfaces with solvent and wipe dry.
   B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.
   C. Prime surfaces scheduled to receive sealant.
   D. Install sealants in accordance with ASTM C1193 and GANA Sealant Manual.
   E. Install sealant in accordance with manufacturer's instructions.

3.03 INSTALLATION - INTERIOR AND EXTERIOR DRY METHOD (TAPE AND GASKET SPLINE GLAZING)
   A. Cut glazing tape to length; install on glazing pane. Seal corners by butting tape and sealing junctions with butyl sealant.
   B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
   C. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
   D. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
   E. Trim protruding tape edge.

3.04 INSTALLATION - INTERIOR AND EXTERIOR WET METHOD (SEALANT AND SEALANT)
   A. Place setting blocks at 1/4 points and install glazing pane or unit.
   B. Install removable stops with glazing centered in space by inserting spacer shims both sides at 24 inch intervals, 1/4 inch below sight line.
   C. Apply sealant to uniform line, parallel with framing system. Tool or wipe sealant surface smooth.
   D. A mechanical anchor (such as structural tape) may be needed to secure doors or windows with unique glazing angles or with narrow exposed clasing ledges.

3.05 INSTALLATION - INTERIOR DRY METHOD (TAPE AND TAPE)
   A. Cut glazing tape to length and set against permanent stops, projecting 1/16 inch (1.6 mm) above sight line.
   B. Place setting blocks at 1/4 points with edge block no more than 6 inches from corners.
   C. Rest glazing on setting blocks and push against tape for full contact at perimeter of pane or unit.
D. Place glazing tape on free perimeter of glazing in same manner described above.
E. Install removable stop without displacement of tape. Exert pressure on tape for full continuous contact.
F. Knife trim protruding tape.

3.06 MANUFACTURER'S FIELD SERVICES
A. Glass and Glazing product manufacturers to provide field surveillance of the installation of their products.
B. Monitor and report installation procedures and unacceptable conditions.

3.07 CLEANING
A. Remove glazing materials from finish surfaces.
B. Remove labels after Work is complete.
C. Clean glass and adjacent surfaces.

END OF SECTION
SECTION 09 05 61
COMMON WORK RESULTS FOR FLOORING PREPARATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. This section applies to floors identified in Contract Documents that are receiving the following types of floor coverings:
   1. Resilient tile.
   2. Fluid applied flooring.
B. Preparation of new and existing concrete floor slabs for installation of floor coverings.
C. Testing of concrete floor slabs for moisture and alkalinity (pH).
D. Remediation of concrete floor slabs due to unsatisfactory moisture or alkalinity (pH) conditions.
   1. Contractor shall perform all specified remediation of concrete floor slabs. If such remediation is indicated by testing agency's report and is due to a condition not under Contractor's control or could not have been predicted by examination prior to entering into the contract, a contract modification will be issued.
E. Patching compound.
F. Remedial floor coatings.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Moisture emission reducing curing and sealing compound for slabs to receive adhered flooring, to prevent moisture content-related flooring failures; to remain in place, not to be removed.

1.03 REFERENCE STANDARDS
C. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordinate scheduling of cleaning and testing, so that preliminary cleaning has been completed for at least 24 hours prior to testing.

1.05 SUBMITTALS
A. Floor Covering and Adhesive Manufacturers' Product Literature: For each specific combination of substrate, floor covering, and adhesive to be used; showing:
   1. Moisture and alkalinity (pH) limits and test methods.
   2. Manufacturer's required bond/compatibility test procedure.
B. Remedial Materials Product Data: Manufacturer's published data on each product to be used for remediation.
C. Testing Agency's Report:
   1. Description of areas tested; include floor plans and photographs if helpful.
   2. Summary of conditions encountered.
3. Moisture and alkalinity (pH) test reports.
5. Recommendations for remediation of unsatisfactory surfaces.
6. Product data for recommended remedial coating.
7. Submit report to Architect.
8. Submit report not more than two business days after conclusion of testing.

D. Adhesive Bond and Compatibility Test Report.

E. North East Collaborative for High Performance Schools (NECHPS) Submittals: Items necessary to document use of sustainable construction materials, products, and practices.

1.06 QUALITY ASSURANCE

A. Moisture and alkalinity (pH) testing shall be performed by an independent testing agency employed and paid by Contractor.

B. Contractor's Responsibility Relating to Independent Agency Testing:
   1. Provide access for and cooperate with testing agency.
   2. Confirm date of start of testing at least 10 days prior to actual start.
   3. Allow at least 4 business days on site for testing agency activities.
   4. Achieve and maintain specified ambient conditions.
   5. Notify Architect when specified ambient conditions have been achieved and when testing will start.

C. Installer Qualifications: Company specializing in performing tile installation, with minimum of five years of documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, handle, and protect products in accordance with manufacturer's instructions and recommendations.

B. Deliver materials in manufacturer's packaging; include installation instructions.

C. Keep materials from freezing.

1.08 FIELD CONDITIONS

A. Maintain ambient temperature in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 65 degrees F or more than 85 degrees F.

B. Maintain relative humidity in spaces where concrete testing is being performed, and for at least 48 hours prior to testing, at not less than 40 percent and not more than 60 percent.

PART 2 PRODUCTS

2.01 MATERIALS

A. Patching Compound: Floor covering manufacturer's recommended product, suitable for conditions, and compatible with adhesive and floor covering. In the absence of any recommendation from flooring manufacturer, provide a product with the following characteristics:
   1. Cementitious moisture-, mildew-, and alkali-resistant compound, compatible with floor, floor covering, and floor covering adhesive, and capable of being feathered to nothing at edges.
   2. Latex or polyvinyl acetate additions are permitted; gypsum content is prohibited.
   3. Compressive Strength: 3000 psi, minimum, after 28 days, when tested in accordance with ASTM C109/C109M or ASTM C472, whichever is appropriate.

B. Remedial Floor Coating: Single- or multi-layer coating or coating/overlay combination intended by its manufacturer to resist water vapor transmission to degree sufficient to meet flooring
manufacturer's emission limits, resistant to the level of alkalinity (pH) found, and suitable for adhesion of flooring without further treatment.
1. Thickness: As required for application and in accordance with manufacturer's installation instructions.
2. Use product recommended by testing agency and flooring system manufacturer.
3. Products: Subject to compliance with flooring manufacturer's requirements, the following products may be provided.
b. ARDEX Engineered Cements; ARDEX MC RAPID: www.ardexamericas.com/#sle.
d. Custom Building Products; TechMVC Moisture Vapor and Alkalinity Barrier: www.custombuildingproducts.com/#sle.
e. H.B. Fuller Construction Products, Inc; TEC LiquiDam with TEC Level Set 200 SLU: www.tecspecialty.com/#sle.
g. Maxxon Corporation; Aquafin SG2: www.maxxon.com/#sle.
i. Tnemec Company, Inc; Series 208 Epoxoprime MVT: www.tnemec.com/#sle.
j. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 CONCRETE SLAB PREPARATION

A. Perform following operations in the order indicated at existing concrete slabs and new concrete slabs:
1. Existing concrete slabs (on-grade and elevated) with existing floor coverings:
   a. Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.
   b. Removal of existing floor covering.
2. Preliminary cleaning.
3. Moisture vapor emission tests; 3 tests in the first 1000 square feet and one test in each additional 1000 square feet, unless otherwise indicated or required by flooring manufacturer.
4. Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
5. Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.
6. Apply remedial floor coating.
   a. Remedial floor coating is to be installed at all floor areas.
   b. Owner may elect to delete remedial floor coating if testing demonstrates that no remediation is required.
7. Patching, smoothing, and leveling, as required.
8. Remove subfloor ridges and bumps. Fill low spots, cracks, joints, holes, and other defects with subfloor filler.
9. Apply, trowel, and float filler to achieve smooth, flat, hard surface. Grind irregularities above the surface level. Prohibit traffic until filler is cured.
10. Other preparation specified.
12. Protection.

3.02 REMOVAL OF EXISTING FLOOR COVERINGS

A. Comply with local, State, and federal regulations and recommendations of RFCI Recommended Work Practices for Removal of Resilient Floor Coverings, as applicable to floor covering being removed.

B. Dispose of removed materials in accordance with local, State, and federal regulations and as specified.

3.03 PRELIMINARY CLEANING

A. Clean floors of dust, solvents, paint, wax, oil, grease, asphalt, residual adhesive, adhesive removers, film-forming curing compounds, sealing compounds, alkaline salts, excessive laitance, mold, mildew, and other materials that might prevent adhesive bond.

B. Do not use solvents or other chemicals for cleaning.

3.04 MOISTURE VAPOR EMISSION TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F1869 and as follows.

D. Plastic sheet test and mat bond test may not be substituted for the specified ASTM test method, as those methods do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if test values exceed 3 pounds per 1000 square feet per 24 hours.

F. Report: Report the information required by the test method.

3.05 INTERNAL RELATIVE HUMIDITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. Where this specification conflicts with the referenced test method, comply with the requirements of this section.

C. Test in accordance with ASTM F2170 Procedure A and as follows.

D. Testing with electrical impedance or resistance apparatus may not be substituted for the specified ASTM test method, as the values determined are not comparable to the ASTM test values and do not quantify the moisture content sufficiently.

E. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if any test value exceeds 75 percent relative humidity.

F. Report: Report the information required by the test method.

3.06 ALKALINITY TESTING

A. Where the floor covering manufacturer's requirements conflict with either the referenced test method or this specification, comply with the manufacturer's requirements.

B. In the event that test values exceed floor covering manufacturer's limits, perform remediation as indicated. In the absence of manufacturer limits, perform remediation if alkalinity (pH) test value is over 10.
3.07 PREPARATION
   A. See individual floor covering section(s) for additional requirements.
   B. Comply with requirements and recommendations of floor covering manufacturer.
   C. Fill and smooth surface cracks, grooves, depressions, control joints and other non-moving joints, and other irregularities with patching compound.
   D. Do not fill expansion joints, isolation joints, or other moving joints.

3.08 ADHESIVE BOND AND COMPATIBILITY TESTING
   A. Comply with requirements and recommendations of floor covering manufacturer.

3.09 APPLICATION OF REMEDIAL FLOOR COATING
   A. Comply with requirements and recommendations of coating manufacturer.

END OF SECTION
PART 1 GENERAL

SECTION 09 21 16
GYPSUM BOARD ASSEMBLIES

1.01 SECTION INCLUDES

A. Metal stud wall, ceiling and soffit framing.
B. Metal framing for top of wall bracing and ceiling framing.
C. Resilient sound isolation clips.
D. Acoustic insulation.
E. Cementitious backing board.
F. Gypsum wallboard.
G. Joint treatment and accessories.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
C. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.
D. Section 07 90 05 - Joint Sealers: Acoustic sealant.

1.03 REFERENCE STANDARDS

B. AISI SG02-1 - North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute. (replaced SG-971)
C. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
D. ASTM A1003/A1003M - Standard Specification for Steel Sheet, Carbon, Metallic- and Nonmetallic-Coated for Cold-Formed Framing Members.
K. ASTM C954 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112 in. (2.84 mm) in Thickness.
L. ASTM C1002 - Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.


U. ASTM E413 - Classification for Rating Sound Insulation.

V. GA-214 - Recommended Levels of Gypsum Board Finish; Gypsum Association.


X. GA-226 - Application of Gypsum Board to Form Curved Surfaces.

Y. UL 752 - Standard for Bullet-Resisting Equipment.

1.04 SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures.

B. Shop Drawings: Indicate special details associated with vertical deflection joints and acoustic seals. Provide special details for suspended ceilings. Indicate layout, anchorage to structure, type and location of fasteners, framed openings, accessories, and items of related work.

C. Product Data: Provide data on metal framing, gypsum board, accessories, and joint finishing system.

D. Product Data: Provide data on cement back board and gypsum sheathing.

E. Product Data: Provide manufacturer's data on partition head to structure connectors, showing compliance with requirements.

1.05 QUALITY ASSURANCE

A. Perform in accordance with ASTM C 840. Comply with requirements of GA-600 for fire-rated assemblies.

B. Installer Qualifications: Company specializing in performing gypsum board application and finishing, with minimum five years of documented experience.

1.06 REGULATORY REQUIREMENTS

A. Conform to applicable code for fire rated assemblies as indicated on drawings.

1.07 DELIVERY, HANDLING, AND STORAGE

A. Deliver materials to project with manufacturer's UL LISTED Labels intact and legible.

PART 2 PRODUCTS

2.01 GYPSUM BOARD ASSEMBLIES

A. Provide completed assemblies per drawings.

2.02 METAL FRAMING MATERIALS

A. Manufacturers - Metal Framing, Connectors, and Accessories:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/360 at 5 psf.
   1. Exception: The minimum metal thickness and section properties requirements of ASTM C645 are waived provided steel of 40 ksi minimum yield strength is used, the metal is continuously dimpled, the effective thickness is at least twice the base metal thickness, and maximum stud heights are determined by testing in accordance with ASTM E 72 using assemblies specified by ASTM C 754.
      a. Acceptable Products:
   2. Studs: "C" shaped with flat or formed webs with knurled faces.
   5. Furring: Hat-shaped sections, minimum depth of 7/8 inch.
   6. Resilient Furring Channels: 1/2 inch depth, for attachment to substrate through one leg only.
      a. Products:
         1) Same manufacturer as other framing materials.
   7. Resilient Sound Isolation Clips: Steel resilient clips with molded rubber isolators, attaches to framing; improves noise isolation performance of wall and floor-ceiling assemblies.

C. Shaft Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 and specified performance requirements.

D. Ceiling Hangers: Type and size as specified in ASTM C754 for spacing required.

E. Partition Head to Structure Connections: Provide mechanical anchorage devices that accommodate deflection using slotted holes, screws and anti-friction bushings, preventing rotation of studs while maintaining structural performance of partition.
   1. Structural Performance: Maintain lateral load resistance and vertical movement capacity required by applicable code, when evaluated in accordance with AISI North American Specification for the Design of Cold-Formed Steel Structural Members.
   3. Provide kickers / framing for top of wall and soffits as necessary.

F. Non-structural Framing Accessories:
   1. Partial Height Wall Framing Support: Provides stud reinforcement and anchored connection to floor.
      b. Products:
         1) ClarkDietrich; Pony Wall (PW): www.clarkdietrich.com/#sle.
         2) Substitutions: See Section 01 60 00 - Product Requirements.
   2. Framing Connectors: ASTM A653/A653M G90 galvanized steel clips; secures cold rolled channel to wall studs for lateral bracing.
      a. Products:
         2) Substitutions: See Section 01 60 00 - Product Requirements.

2.03 BOARD MATERIALS

A. Manufacturers - Gypsum-Based Board:
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Abuse Resistant Wallboard:
1. Application: Walls.
2. Surface Abrasion: Level 2, minimum, when tested in accordance with ASTM C1629/C1629M.
3. Indentation: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
4. Soft Body Impact: Level 1, minimum, when tested in accordance with ASTM C1629/C1629M.
5. Paper-Faced Type: Gypsum wallboard, as defined in ASTM C1396/C1396M.
6. Type: Fire-resistance-rated Type X, UL or WH listed.

C. Backing Board For Wet Areas: One of the following products:
1. Application: Surfaces behind tile in wet areas.
2. Application: Horizontal surfaces behind tile in wet areas including countertops.
3. ANSI Cement-Based Board: Non-gypsum-based; aggregated Portland cement panels with glass fiber mesh embedded in front and back surfaces complying with ANSI A118.9-SystemDeleted or ASTM C1325.
   a. Thickness: 1/2 inch.
   b. Products:
      1) Custom Building Products: Wonderboard.
      2) National Gypsum Company: PermaBase Brand Cement Board.
      3) USG Corporation: www.usg.com/#sle.
      4) Substitutions: See Section 01 60 00 - Product Requirements.

D. Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
1. Application: Ceilings, unless otherwise indicated.
2. Thickness: 1/2 inch.

2.04 ACCESSORIES
A. Acoustic Insulation: ASTM C 665; preformed glass fiber, friction fit type, unfaced. Thickness to fit cavity. As specified in Section 07 21 00.

B. Sound Isolation Tape: Elastomeric foam tape for sound decoupling.
1. Surface Burning Characteristics: Provide assemblies with flame spread index of 75 or less and smoke developed index of 450 or less, when tested in accordance with ASTM E84.
   2. Tape Thickness: 1/4 inch.

C. Acoustic Sealant: Acrylic emulsion latex or water-based elastomeric sealant; do not use solvent-based non-curing butyl sealant.

D. Finishing Accessories: ASTM C1047, rigid plastic, unless otherwise indicated.
1. Types: As detailed or required for finished appearance.
2. Special Shapes: In addition to conventional cornerbead and control joints, provide U-bead at exposed panel edges.

E. Beads, Joint Accessories, and Other Trim: ASTM C1047, rigid plastic, galvanized steel, or rolled zinc, unless noted otherwise.
F. Joint Materials: ASTM C475 and as recommended by gypsum board manufacturer for project conditions.
   1. Tape: 2 inch wide, coated glass fiber tape for joints and corners, except as otherwise indicated.
   2. Tape: 2 inch wide, creased paper tape for joints and corners, except as otherwise indicated.
   5. Chemical hardening type compound.

G. Screws for Attachment to Steel Members Less Than 0.03 inch In Thickness, to Wood Members, and to Gypsum Board: ASTM C1002; self-piercing tapping type; cadmium-plated for exterior locations.

H. Screws for Attachment to Steel Members From 0.033 to 0.112 Inch in Thickness: ASTM C954; steel drill screws for application of gypsum board to loadbearing steel studs.

I. Screws: ASTM C 1002; self-piercing tapping type; cadmium-plated for exterior locations.

J. Staples: ASTM C 840.

K. Anchorage to Substrate: Tie wire, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that project conditions are appropriate for work of this section to commence.

3.02 FRAMING INSTALLATION

A. Metal Framing: Install in accordance with ASTM C754 and manufacturer's instructions.

B. Suspended Ceilings and Soffits: Space framing and furring members as indicated.
   1. Level ceiling system to a tolerance of 1/600.
   2. Laterally brace entire suspension system, to structure above.
   3. Install bracing as required at exterior locations to resist wind uplift.

C. Studs: Space studs as indicated.
   1. Extend partition framing to structure where indicated and to ceiling in other locations.
   2. Partitions Terminating at Ceiling: Attach ceiling runner securely to ceiling framing in accordance with details.
   3. Partitions Terminating at Structure: Attach extended leg top runner to structure, maintain clearance between top of studs and structure, and brace both flanges of studs with continuous bridging.
   4. Partitions Terminating at Structure: Attach top runner to structure, maintain clearance between top of studs and structure, and connect studs to track using specified mechanical devices in accordance with manufacturer's instructions; verify free movement of top of stud connections; do not leave studs unattached to track.

D. Openings: Reinforce openings as required for weight of doors or operable panels, using not less than double studs at jambs.

E. Connections: Minimum (4) #12 screws per connection of cold formed metal framing members.

F. Standard Wall Furring: Install at concrete and masonry walls scheduled to receive gypsum board, not more than 4 inches from floor and ceiling lines and abutting walls. Secure in place on alternate channel flanges at maximum 24 inches on center.
   1. Orientation: Horizontal; or Vertical.
   2. Spacing: At 16 inches on center; or As permitted by standard.
G. Blocking: Install wood blocking for support of:
   1. Framed openings.
   2. Wall-mounted cabinets.
   3. Plumbing fixtures.
   4. Toilet partitions.
   5. Toilet accessories.
   6. Wall-mounted door hardware.

### 3.03 ACOUSTIC ACCESSORIES INSTALLATION

A. Acoustic Insulation: Place tightly within spaces, around cut openings, behind and around electrical and mechanical items within partitions, and tight to items passing through partitions.

B. Sound Isolation Tape: Apply to vertical studs and top and bottom tracks/runners in accordance with manufacturer's instructions.

C. Acoustic Sealant: Install as follows:
   1. Place two beads continuously on substrate before installation of perimeter framing members.
   2. Place continuous bead at perimeter of each layer of gypsum board.
   3. In non-fire-rated construction, seal around all penetrations by conduit, pipe, ducts, and rough-in boxes; and other penetrations.

### 3.04 BOARD INSTALLATION

A. Comply with ASTM C 840 and manufacturer's instructions. Install to minimize butt end joints, especially in highly visible locations.

B. Single-Layer Non-Rated: Install gypsum board in most economical direction, with ends and edges occurring over firm bearing.
   1. Exception: Tapered edges to receive joint treatment at right angles to framing.

C. Exterior Soffits: Install exterior soffit board perpendicular to framing, with staggered end joints over framing members or other solid backing.
   1. Seal joints, cut edges, and holes with water-resistant sealant.

D. Cementitious Backing Board: Install over steel framing members where indicated, in accordance with ANSI A108.11-SystemDeleted and manufacturer's instructions.

E. Installation on Metal Framing: Use screws for attachment of all gypsum board except face layer of non-rated double-layer assemblies, which may be installed by means of adhesive lamination.

F. Curved Surfaces: Apply gypsum board to curved substrates in accordance with GA-226.

### 3.05 INSTALLATION OF TRIM AND ACCESSORIES

A. Control Joints: Place control joints consistent with lines of building spaces and as directed.
   1. Not more than 30 feet apart on walls and ceilings over 50 feet long.

B. Corner Beads: Install at external corners, using longest practical lengths.

C. Edge Trim: Install at locations where gypsum board abuts dissimilar materials and as indicated.

### 3.06 JOINT TREATMENT

A. Glass Mat Faced Gypsum Board and Exterior Glass Mat Faced Sheathing: Use fiberglass joint tape, embed and finish with setting type joint compound.

B. Paper Faced Gypsum Board: Use fiberglass joint tape, bedded with ready-mixed vinyl-based; or powder-type vinyl-based; or chemical hardening type joint compound and finished with
ready-mixed vinyl-based; or powder-type vinyl-based; or chemical hardening type joint compound.

C. Finish gypsum board in accordance with levels defined in ASTM C840, as follows:
   1. Level 4: Walls and ceilings to receive paint finish or wall coverings, unless otherwise indicated.
   2. Level 2: In utility areas, behind cabinetry, and on backing board to receive tile finish or where FRP panel to be installed.
   3. Level 1: Fire rated wall areas above finished ceilings, whether or not accessible in the completed construction.

D. Finish gypsum board in scheduled areas in accordance with levels defined in GA-214; or ASTM C 840 and as scheduled below.
   1. Above Finished Ceilings Concealed From View: Level 1.
   2. Utility Areas and Areas Behind Cabinetry: Level 2.

E. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   1. Feather coats of joint compound so that camber is maximum 1/32 inch.
   2. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile and fixed cabinetry.
   3. Taping, filling and sanding is not required at base layer of double layer applications.

3.07 TOLERANCES
A. Maximum Variation of Finished Gypsum Board Surface from True Flatness: 1/8 inch in 10 feet in any direction.

3.08 FINISH LEVEL SCHEDULE (SEE 1.03 REFERENCES FOR DEFINITION)
A. Level 1: Above finished ceilings concealed from view.
B. Level 2: Utility areas and areas behind cabinetry or where FRP will be applied.
C. Level 4: Walls and ceilings scheduled to receive flat paint finish.

END OF SECTION
SECTION 09 25 13
ACRYLIC PLASTERING

PART 1 - GENERAL

1.01 SECTION INCLUDES
   A. Installation of a cementitious acrylic basecoat, reinforcing mesh, [primer,] and finish installed on exterior soffits

1.02 RELATED SECTIONS
   A. Section 07 90 05 - Joint Sealers

1.03 REFERENCES
   A. ASTM B117 - Test Method for Salt Spray (Fog) Testing
   B. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity
   C. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials
   D. ASTM E331 - Test Method for Water Penetration by Uniform Static Air Pressure Difference
   H. ASTM G155/G153 - Accelerated Weathering for Exposure of Nonmetallic Materials

1.04 ASSEMBLY DESCRIPTION
   A. An exterior coating system consisting of basecoat with embedded reinforcing fabric mesh, primer, and finish coat.
   B. Functional Criteria
      1. General:
         a. This application is for soffits only.
         b. Control joints shall be installed 32 ft. (9.75 m) on center maximum as per sheathing manufacturer’s recommendations.
         c. Building code conformance: The construction shall be acceptable for use under the building code in force in the jurisdiction of the project.
         d. Prevent the accumulation of water behind the finish system, by proper design and detailing of the soffit and related construction.
         e. Performance Requirements
            1) Shall meet the testing requirements of the Parex Product Performance Sheet.

1.05 SUBMITTALS
   A. Samples: Submit samples for approval. Samples shall be of materials specified and of suitable size as required to accurately represent each color and texture used on project. Prepare each sample using same tools and techniques for actual project application. Maintain and make available, at job site, approved samples.
   B. Manufacturer’s Warranty: Submit sample copies of Manufacturer’s Warranty indicating Single Source Responsibility

1.06 QUALITY ASSURANCE
   A. Qualifications:
1. Manufacturer: Shall have marketed EIFS assemblies in United States for at least ten years and shall have completed projects of same general scope and complexity.
2. Applicator: Shall be experienced and competent in installation of EIFS materials, and shall provide evidence of a minimum of five years experience in work similar to that required by this section.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Delivery: Deliver products in original packaging with manufacturer's identification.
B. Storage: Store materials in a cool, dry location, out of sunlight, protected from weather and other harmful environment, and at a temperature above 40°F (4.4°C) and below 110°F (43°C) in accordance with manufacturer's instructions.

1.08 PROJECT / SITE CONDITIONS
A. Installation Ambient Air Temperature: Minimum of 40°F (4°C) and rising, and remain so for 24 hours thereafter.
B. Substrate Temperature: Do not apply materials to substrates whose temperature are below 40°F (4.4°C) or contain frost or ice.
C. Inclement Weather: Do not apply materials during inclement weather, unless appropriate protection is employed.
D. Sunlight Exposure: Avoid, when possible, installation of the materials in direct sunlight. Application of finishes in direct sunlight in hot weather may adversely affect aesthetics.
E. Parex materials shall not be applied if ambient temperature exceeds 120°F (49°C) or falls below 40°F (4.4°C) within 24 hours of application. Protect from uneven and excessive evaporation during hot, dry weather.
F. Prior to installation, the substrate shall be inspected for surface contamination, or other defects that may adversely affect the performance of the ACF materials and shall be free of residual moisture.

1.09 COORDINATION AND SCHEDULING:
A. Coordination: Coordinate Architectural Coatings and Finishes installation with other construction operations.

1.10 WARRANTY
A. Warranty: Upon request, at completion of installation, provide manufacturer's Standard Limited Warranty.

PART 2 - PRODUCTS
2.01 MANUFACTURERS
A. Manufacturer, Basis of Design: Parex USA, Inc., 4125 E. La Palma Ave., Suite 250, Anaheim, CA 92807; Contact: Susan Foster-Goodman, Architectural Sales & National Accounts Manager (714.319.3186 or 866.516.0061) or Technical Services (800.226-2424).
B. Components: Obtain components of ACF from authorized distributors. No substitutions or additions of other materials are permitted without prior written permission from the manufacturer for this project.
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
A. Basecoat:
1. 121 Basecoat: 100% acrylic polymer base, requiring the addition of portland cement.
2. 121 Dry Basecoat: 100% acrylic copolymer based, factory blend of cement and proprietary ingredients requiring addition of water.

B. Reinforcing Mesh (Impact resistance refers to installation of EPS trim):
1. 355 Standard Mesh: Weight 4.5 oz. per sq. yd. (153 g/sq m); coated for protection against alkali. Standard reinforcement or for use with High Impact 358.14 Mesh, or Ultra High Impact 358.20 Mesh.
2. 356 Short Detail Mesh: Reinforcing mesh used for backwrapping and details, and to embed in the Parex Base Coat & Adhesive 121 or 121 Dry.
3. 352 Self Adhesive Detail Mesh: Reinforcing mesh used for complex details

C. Primer:
1. Parex USA Primer: 100% acrylic based coating to prepare surfaces for Parex finishes.
2. VariPrime Sanded: 100% acrylic based coating to prepare surface for exposed aggregate specialty finishes.

D. Finish:
1. Parex DPR Standard Finish: Factory blended, 100% acrylic polymer based finish, integrally colored. Finish type, texture and color as selected by Architect.

E. Water: Clean, potable water
F. Portland Cement: ASTM C150, Type I or Type I-II.

2.03 RELATED MATERIALS AND ACCESSORIES
A. Water-Resistive barrier, if required by local code official
B. Substrate Materials
1. Dens-Glass Gold by Georgia-Pacific Corp. minimum ½” (12.7 mm) thick.
2. Eterspan by Eternit, minimum ½” (12.7 mm) thick.
3. Harditex by James Hardie Building Products, minimum ½” (12.7 mm) thick.
4. PermaBase Sheathing by National Gypsum Co., minimum ½” (12.7 mm) thick.
5. Concrete (poured or pre-cast).
6. Other approved by Parex USA in writing prior to the project

C. Sealant System:
1. Sealant for perimeter seals around window and door frames and other wall penetrations shall be low modulus, designed for minimum 50% elongation and minimum 25% compression, and as selected by Architect.
2. Sealants shall conform to ASTM C920, Grade NS.
3. Perimeter seal joints shall be a minimum width of 1/2 in (12.7 mm).
4. Sealant backer rod shall be closed-cell polyethylene foam.
5. Apply sealant to tracks or basecoat.
6. Refer to Parex USA current Technical Bulletin for listing of sealants which have been tested and found to be compatible with Parex materials.
7. Color shall be as selected by Architect.
8. Joint design, surface preparation, and sealant primer shall be based on sealant manufacturer's recommendations and project conditions.

PART 3 - EXECUTION
3.01 EXAMINATION
A. Verify project site conditions under provisions of Section 01 00 00.
B. Compliance: Comply with manufacturer's instructions for installation of ACF products.
C. Substrate Examination: Examine prior to basecoat installation as follows:
1. Substrate shall be free of dust, dirt, laitance, efflorescence, and other harmful contaminants.
2. Substrate construction in accordance with substrate material manufacturer's specifications and applicable building codes.
3. Maximum deflection of the substrate shall be limited to L/240. Screw heads shall be driven flush with face of sheathing substrate.
4. Sheathing substrate shall be butted tightly at all joints.
D. Advise Contractor of discrepancies preventing proper installation of the ACF materials. Do not proceed with work until unsatisfactory conditions are corrected.

3.02 PREPARATION
A. Protection: Protect surrounding material surfaces and areas during installation of system.
B. Clean surfaces thoroughly prior to installation.
C. Prepare surfaces using the methods recommended by the Manufacturer for achieving the best result for the substrate under the project conditions.
D. Water Resistive Barrier by others: Install in accordance with manufacturer’s installation instructions.
E. Install Sheathing in accordance with manufacturers installation instructions.

3.03 MIXING
A. Mix proprietary products in accordance with Manufacturer's instructions.

3.04 APPLICATION
A. General: Installation shall conform to this specification and Parex USA written instructions and drawing details.
B. Base Coat: Apply base coat and fully embed mesh in base coat; include diagonal mesh patches at corners of openings and reinforcing mesh patches at joints of track sections.
C. Apply primer if specified to base coat after drying.
D. Finish Coat: Apply finish coat to match specified finish type, texture, and color. Do not apply finish coat to surfaces to receive sealant. Keep finish out of sealant joint gaps.

3.05 CLEAN-UP
A. Removal: Remove and legally dispose of debris material from the job site.
B. Clean ACF surfaces and work area of foreign materials resulting from application.

3.06 PROTECTION
A. Provide protection of installed materials from water infiltration into or behind them.
B. Provide protection of installed ACF from dust, dirt, precipitation, and freezing during installation.
C. Provide protection of installed finish from dust, dirt, precipitation, freezing and continuous high humidity until fully cured and dry.
D. Clean exposed surfaces using materials and methods recommended by the manufacturer of the material or product being cleaned. Remove and replace work that cannot be cleaned to the satisfaction of the Architect/Owner.
SECTION 09 30 00
TILING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Tile for floor applications.
   B. Tile for wall applications.
   C. Cementitious backer board as tile substrate.
   D. Ceramic trim.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
   C. Section 07 90 05 - Joint Sealers.

1.03 REFERENCE STANDARDS
     10. ANSI A108.11-SystemDeleted - American National Standard for Interior Installation of Cementitious Backer Units.
15. ANSI A118.4 - American National Standard Specifications for Modified Dry-Set Cement Mortar.
19. ANSI A118.9-SystemDeleted - American National Standard Specifications for Test Methods and Specifications for Cementitious Backer Units.


1.04 SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturers' data sheets on tile, mortar, grout, and accessories. Include instructions for using grouts and adhesives.
C. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.
D. Samples: Mount tile and apply grout on two plywood panels, minimum 18 x 18 inches in size illustrating pattern, color variations, and grout joint size variations.
E. Manufacturer’s Certificate: Certify that products meet or exceed specified requirements.
F. Maintenance Data: Include recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

1.05 QUALITY ASSURANCE
B. Manufacturer Qualifications: Company specializing in manufacturing the types of products specified in this section, with minimum ten years of documented experience.
C. Installer Qualifications:
   1. Company specializing in performing tile installation, with minimum of five years of documented experience.
D. Installer Qualifications: Company specializing in performing tile installation, with minimum of 5 years of documented experience.

1.06 MOCK-UP
A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
B. Construct tile mock-up where indicated on the drawings, incorporating all components specified for the location.
   1. Minimum size of mock-up is indicated on the drawings.
   2. Approved mock-up may remain as part of the Work.
   3. Demolish mock-up when directed by Architect, and remove debris from the site.

1.07 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this section.
1.08 DELIVERY, STORAGE, AND HANDLING
   A. Protect materials from freezing or overheating in accordance with manufacturer's instructions.

1.09 FIELD CONDITIONS
   A. Maintain ambient and substrate temperature of 50 degrees F during installation of mortar materials.

1.10 EXTRA MATERIALS
   A. Provide 2 percent of each size, color, and surface finish of tile specified, but not less than 50 of each type.
   B. See Section 01 60 00 - Product Requirements, for additional provisions.

PART 2 PRODUCTS

2.01 TILE
   A. Manufacturers: All products by the same manufacturer.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Ceramic Mosaic Floor Tile: ANSI A137.1
      1. [Keystones Group 3 and 4] Manufactured by [Daltile].
      2. Moisture Absorption: 0 to 0.5 percent.
      3. Size and Shape: 2" x 2".
      5. Colors: 3 color mosaic pattern.
   C. Glazed Wall Tile: ANSI A137.1, and as follows:
      1. Bright & Matte manufactured by American Olean.
      2. Size and Shape: 4-1/4 inch square.
      3. Edges: Cushioned.
      5. Color: Matte Designer White 0061.
      6. Colors: See drawings for color selections.
      7. Pattern: See drawings for pattern.
      8. Trim Units: Matching bullnose, cove, and base shapes in sizes coordinated with field tile.

2.02 TRIM AND ACCESSORIES
   A. Ceramic Trim: Matching bullnose, double bullnose, cove base, and cove ceramic shapes in sizes coordinated with field tile.
      1. Manufacturers: Same as for tile.
   B. Non-Ceramic Trim: Brushed stainless steel, style and dimensions to suit application, as indicated on drawings for setting using tile mortar or adhesive.
      1. Applications: Use in the following locations:
         a. Open edges of floor tile.
         b. Transition between floor finishes of different heights.
         c. Expansion and control joints, floor and wall.
         d. Floor to wall joints.
      2. Manufacturer:
         b. Substitutions: See Section 01 60 00 - Product Requirements.
2.03 SETTING MATERIALS
   A. Epoxy Adhesive and Mortar Bond Coat: ANSI A118.3.
      1. Applications: Where indicated on drawings.
      2. Products:
         b. LATICRETE International, Inc; LATICRETE LATAPOXY 300 Adhesive: www.laticrete.com/#sle.
         c. Merkrete, by Parex USA, Inc; Merkrete Pro Epoxy: www.merkrete.com/#sle.
         d. Sika Corp; SikaTile 350 Flex Set: www.sika.com/#sle.
         e. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 GROUTS
   A. Manufacturers:
      1. ARDEX Engineered Cements: www.ardexamericas.com/#sle.
      5. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Standard Grout: Polymer modified cement grout, sanded, as specified in ANSI A118.7.

2.05 THIN-SET ACCESSORY MATERIALS
   A. Floor Patch/Leveler
   B. Cementitious Backer Board: ANSI A118.9; High density, cementitious, glass fiber reinforced, 1/2 inch thick; 2 inch wide coated glass fiber tape for joints and corners.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive tile.
   B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive tile.
   C. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of setting materials to sub-floor surfaces.
   D. Verify that concrete sub-floor surfaces are ready for tile installation by testing for moisture emission rate and alkalinity; obtain instructions if test results are not within limits recommended by tile manufacturer and setting materials manufacturer.
   E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION
   A. Protect surrounding work from damage.
   B. Vacuum clean surfaces and damp clean.
   C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances. With floor patch leveler.
   D. Install backer board in accordance with ANSI A108.11-SystemDeleted and board manufacturer's instructions. Tape joints and corners, cover with skim coat of setting material to a feather edge.
E. Install cementitious backer board in accordance with ANSI A108.11 and board manufacturer's instructions. Tape joints and corners, cover with skim coat of dry-set mortar to a feather edge.

3.03 INSTALLATION - GENERAL
A. Install tile, thresholds, and stair treads and grout in accordance with applicable requirements of ANSI A108.1 through A108.13, manufacturer's instructions, and The Tile Council of North America Handbook recommendations.
B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
C. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor joints.
D. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make grout joints without voids, cracks, excess mortar or excess grout, or too little grout.
E. Form internal angles square and external angles bullnosed.
F. Sound tile after setting. Replace hollow sounding units.
G. Keep expansion joints free of adhesive or grout. Apply sealant to joints.
H. Prior to grouting, allow installation to completely cure; minimum of 48 hours.
I. Grout tile joints. Use standard grout unless otherwise indicated.
J. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

3.04 INSTALLATION - FLOORS - THIN-SET METHODS
A. Over interior concrete substrates, install in accordance with TCNA (HB) Method F113, dry-set or latex-Portland cement bond coat, with standard grout, unless otherwise indicated.

3.05 INSTALLATION - WALL TILE
A. Over cementitious backer units on studs, install in accordance with The Tile Council of North America Handbook Method W244, using membrane at toilet rooms.
B. Over gypsum wallboard on wood or metal studs install in accordance with The Tile Council of North America Handbook Method W243, thin-set with dry-set or latex-Portland cement bond coat, unless otherwise indicated.

3.06 CLEANING
A. Clean tile and grout surfaces.

3.07 PROTECTION
A. Do not permit traffic over finished floor surface for 4 days or manufacturer's recommended curing time after installation.

END OF SECTION
SECTION 09 51 00
ACOUSTICAL CEILINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Suspended metal grid ceiling system.
   B. Acoustical units.
   C. Support hangers, channels, and wires.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
   C. Section 23 37 00 - Air Outlets and Inlets: Air diffusion devices in ceiling.
   D. Section 26 51 00 - Interior Lighting: Light fixtures in ceiling system.

1.03 REFERENCE STANDARDS
   C. ASTM E1264 - Standard Classification for Acoustical Ceiling Products.

1.04 SUBMITTALS
   A. See Section 01 30 00 - General Conditions, for submittal procedures.
   B. See Section 01 33 00 - Submittal Procedures
   C. Shop Drawings: Indicate grid layout and related dimensioning, junctions with other ceiling finishes, and mechanical and electrical items installed in the ceiling.
   D. Product Data: Provide data on suspension system components and acoustical units.
   E. Samples: Submit two samples 4x4 inch in size illustrating material and finish of acoustical units.
   F. Manufacturer’s Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.

1.05 QUALITY ASSURANCE
   A. Suspension System Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
   B. Acoustical Unit Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum ten years documented experience.
   C. Installer Qualifications: Company specializing in performing the type of work specified with minimum [five] years experience.

1.06 FIELD CONDITIONS
   A. Maintain uniform temperature of minimum 60 degrees F, and maximum humidity of 40 percent prior to, during, and after acoustical unit installation.
1.07 PROJECT CONDITIONS
   A. Sequence work to ensure acoustical ceilings are not installed until building is enclosed, sufficient heat is provided, dust generating activities have terminated, and overhead work is completed, tested, and approved.
   B. Install acoustical units after interior wet work is dry.

1.08 EXTRA MATERIALS
   A. See Section 01 60 00 - Product Requirements, for additional provisions.
   B. Provide 100 SF of Type A1 acoustical unit, for Owner's use in maintenance of project.
   C. Provide 1 box of Type A2 acoustical unit, for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Basis-of-Design: Armstrong World Industries, Inc.
   B. Acoustic Tiles/Panels:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ACOUSTICAL UNITS
   A. Acoustical Units - General: ASTM E1264, Class A.
   B. Acoustical Panels: Mineral fiber with membrane-faced overlay, with the following characteristics:
      1. Classification: ASTM E1264 Type IV.
      2. Size: 24 by 24 inches.
      7. Products:
         b. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 SUSPENSION SYSTEM(S) UNLESS NOTED OTHERWISE ABOVE.
   A. Manufacturers:
      1. Same as for acoustical units.
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Exposed Suspension System: Hot-dipped galvanized steel grid and cap.
      1. Structural Classification: Heavy-duty, when tested in accordance with ASTM C635/C635M.
      2. Profile: Tee; 15/16 inch face width.
      3. Finish: Baked enamel.

2.04 ACCESSORIES
   A. Support Channels and Hangers: Galvanized steel; size and type to suit application and ceiling system flatness requirement specified.
   B. Perimeter Moldings: Same material and finish as grid.
C. Gasket For Perimeter Moldings: Closed cell rubber sponge tape.
D. Touch-up Paint: Type and color to match acoustical and grid units.

PART 3  EXECUTION

3.01  EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that layout of hangers will not interfere with other work.

3.02  PREPARATION
A. Install after major above-ceiling work is complete.
B. Coordinate the location of hangers with other work.

3.03  INSTALLATION - SUSPENSION SYSTEM
A. Install suspension system in accordance with ASTM C 636, ASTM E 580, and manufacturer's instructions and as supplemented in this section.
B. Rigidly secure system, including integral mechanical and electrical components, for maximum deflection of 1:240.
C. Lay out system to a balanced grid design with edge units no less than 50 percent of acoustical unit size, unless indicated otherwise on reflected ceiling plan
D. Locate system on room axis according to reflected ceiling plan.
E. Install after major above-ceiling work is complete. Coordinate the location of hangers with other work.
F. Hang suspension system independent of walls, columns, ducts, pipes and conduit. Where carrying members are spliced, avoid visible displacement of face plane of adjacent members.
G. Where ducts or other equipment prevent the regular spacing of hangers, reinforce the nearest affected hangers and related carrying channels to span the extra distance.
H. Do not support components on main runners or cross runners if weight causes total dead load to exceed deflection capability.
I. Support fixture loads using supplementary hangers located within 6 inches of each corner, or support components independently.
J. Do not eccentrically load system or induce rotation of runners.
K. Perimeter Molding: Install at intersection of ceiling and vertical surfaces and at junctions with other interruptions.
   1. Install in bed of acoustical sealant or in bed of acoustical sealant.
   2. Use longest practical lengths.
   3. Miter or Overlap and rivet corners.
L. Form expansion joints as detailed. Form to accommodate plus or minus 1 inch movement. Maintain visual closure.

3.04  INSTALLATION - ACOUSTICAL UNITS
A. Install acoustical units in accordance with manufacturer's instructions.
B. Fit acoustical units in place, free from damaged edges or other defects detrimental to appearance and function.
C. Fit border trim neatly against abutting surfaces.
D. Install units after above-ceiling work is complete.
E. Install acoustical units level, in uniform plane, and free from twist, warp, and dents.
F. Cutting Acoustical Units:
   1. Cut to fit irregular grid and perimeter edge trim.
   2. Make field cut edges of same profile as factory edges.
   3. Double cut and field paint exposed reveal edges.

G. Where round obstructions and bullnose corners occur, provide preformed closures to match perimeter molding.

3.05 TOLERANCES
A. Maximum Variation from Flat and Level Surface: 1/8 inch in 10 feet.
B. Maximum Variation from Plumb of Grid Members Caused by Eccentric Loads: 2 degrees.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
   A.  Resilient tile flooring.
   B.  Resilient base and pre-molded internal / external corners for tile carpet and resilient tile.
   C.  Installation accessories.

1.02  RELATED REQUIREMENTS
   A.  Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B.  Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation, and installation of remedial floor coating.
   C.  Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing, remediation procedures, and installation of remedial floor coating.

1.03  REFERENCE STANDARDS
   B.  ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
   G.  BAAQMD 8-51 - Bay Area Air Quality Management District Regulation 8, Rule 51, Adhesive and Sealant Products; www.baaqmd.gov.
   J.  SCAQMD 1168 - South Coast Air Quality Management District Rule No.1168; www.aqmd.gov.

1.04  SUBMITTALS
   A.  See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B.  See Section 01 33 00 - Submittal Procedures.
   C.  Product Data: Provide data on specified products, describing physical and performance characteristics; including sizes, patterns and colors available; and installation instructions.
   D.  Selection Samples: Submit manufacturer's complete set of color samples for Architect's initial selection.
   E.  Verification Samples: Submit two samples, 12x12 inch in size illustrating color and pattern for each resilient flooring product specified.
   F.  Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
   G.  Certification: Prior to installation of flooring, submit written certification by flooring manufacturer and adhesive manufacturer that condition of subfloor is acceptable.
   H.  Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning, stripping, and re-waxing.
   I.  Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Flooring Material: 50 square feet of each type and color.
3. Extra Wall Base: 50 linear feet of each type and color.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing specified flooring with minimum ten years documented experience.
B. Installer Qualifications: Company specializing in installing specified flooring with minimum five years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Upon receipt, immediately remove any shrink-wrap and check materials for damage and the correct style, color, quantity and run numbers.
B. Store all materials off of the floor in an acclimatized, weather-tight space.
C. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
D. Do not double stack pallets.

1.07 FIELD CONDITIONS
A. Maintain temperature in storage area between 55 degrees F and 90 degrees F.
B. Store materials for not less than 48 hours prior to installation in area of installation at a temperature of 70 degrees F to achieve temperature stability. Thereafter, maintain conditions above 55 degrees F.

PART 2 PRODUCTS
2.01 TILE FLOORING
A. Vinyl Composition Tile: Homogeneous, with uniform color extending throughout thickness
1. Manufacturers:
   d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Minimum Requirements: Comply with ASTM F 1066, of Class corresponding to type specified. Composition 1, class 2.
3. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648.
4. Size: 12 x 12 inch.
5. Thickness: 0.125 inch.
7. Color: As indicated on drawings.

2.02 RESILIENT BASE
A. Resilient Base - Type RB-1: ASTM F 1861, Type TP, rubber, thermoplastic; Style B, Cove, and as follows:
1. Manufacturers:
   c. Substitutions: See Section 01 60 00 - Product Requirements.
2. Critical Radiant Flux (CRF): Minimum 0.45 watt per square centimeter, when tested in accordance with ASTM E 648 or NFPA 253.
3. Height: 4 inch.
4. Thickness: 0.125 inch thick.
5. Finish: Satin.
7. Color: To be selected by Architect from manufacturer's full range.
8. Internal and External Corners: Pre-molded

2.03 ACCESSORIES
A. Subfloor Filler: White premix latex; type recommended by adhesive material manufacturer.
B. Primers, Adhesives, and Seaming Materials: Waterproof; types recommended by flooring manufacturer.
   1. VOC Content Limits: As specified in Section 01 61 16.
C. Moldings and Edge Strips: Same material as flooring.
D. Filler for Coved Base: Plastic or as recommended by manufacturer.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that surfaces are flat to tolerances acceptable to flooring manufacturer, free of cracks that might telegraph through flooring, clean, dry, and free of curing compounds, surface hardeners, and other chemicals that might interfere with bonding of flooring to substrate.
B. Verify that sub-floor surfaces are smooth and flat within the tolerances specified for that type of work and are ready to receive resilient flooring.
C. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive resilient base.
D. Verify that sub-floor surfaces are dust-free and free of substances that could impair bonding of adhesive materials to sub-floor surfaces.
E. Verify that required floor-mounted utilities are in correct location.

3.02 PREPARATION
A. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61, including installation of remedial floor coating.
B. Prepare floor substrates as recommended by flooring and adhesive manufacturers.
C. Remove sub-floor ridges and bumps. Fill minor low spots, cracks, joints, holes, and other defects with sub-floor filler to achieve smooth, flat, hard surface.
D. Prohibit traffic until filler is cured.
E. Clean substrate.
F. Apply primer as required to prevent "bleed-through" or interference with adhesion by substances that cannot be removed.

3.03 INSTALLATION
A. Starting installation constitutes acceptance of sub-floor conditions.
B. Install in accordance with manufacturer's instructions.
C. Adhesive-Applied Installation:
   1. Spread only enough adhesive to permit installation of materials before initial set.
   2. Fit joints and butt seams tightly.
   3. Set flooring in place, press with heavy roller to attain full adhesion.
D. Where type of floor finish, pattern, or color are different on opposite sides of door, terminate flooring under centerline of door.
E. Install edge strips at unprotected or exposed edges, where flooring terminates, and where indicated.
   1. Metal Strips: Attach to substrate before installation of flooring using stainless steel screws.
   2. Resilient Strips: Attach to substrate using adhesive.
F. Scribe flooring to walls, columns, cabinets, floor outlets, and other appurtenances to produce tight joints.
G. Install flooring in recessed floor access covers, maintaining floor pattern.

3.04 TILE FLOORING
   A. Install in accordance with manufacturer’s instructions.
   B. Install custom cut/shape per drawings.
   C. Mix tile from container to ensure shade variations are consistent when tile is placed, unless manufacturer’s instructions say otherwise.
   D. Lay flooring with joints and seams parallel or as shown on plans to building lines to produce symmetrical tile pattern.

3.05 RESILIENT BASE
   A. Fit joints tightly and make vertical. Maintain minimum dimension of 48 inches between joints.
   B. At external and internal corners, use premolded units. At exposed ends, use premolded units.
   C. Install base on solid backing. Bond tightly to wall and floor surfaces.
   D. Scribe and fit to door frames and other interruptions.

3.06 CLEANING
   A. Remove excess adhesive from floor, base, and wall surfaces without damage.
   B. Clean in accordance with manufacturer’s written instructions.

3.07 PROTECTION
   A. Prohibit traffic on resilient flooring for 48 hours after installation.

END OF SECTION
SECTION 09 68 13
TILE CARPETING

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Carpet tile, fully adhered.
B. Removal of existing carpet tile.

1.02  RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
B. Section 01 74 19 - Construction Waste Management and Disposal: Reclamation/Recycling of new carpet tile scrap, removed carpet tile, and ______.
C. Section 03 30 00 - Cast-in-Place Concrete: Restrictions on curing compounds for concrete slabs and floors to receive adhesive-applied flooring.
D. Section 09 05 61 - Common Work Results for Flooring Preparation: Removal of existing floor coverings, cleaning, and preparation.
E. Section 09 05 61 - Common Work Results for Flooring Preparation: Concrete slab moisture and alkalinity testing and remediation procedures.

1.03  REFERENCE STANDARDS

C. ASTM F710 - Standard Practice for Preparing Concrete Floors to Receive Resilient Flooring.
D. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
F. CRI 104 - Standard for Installation of Commercial Carpet.
G. CRI 105 - Standard for Installation of Residential Carpet.
H. CRI (GLP) - Green Label Plus Testing Program - Certified Products.

1.04  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data on specified products, describing physical and performance characteristics; sizes, patterns, colors available, and method of installation.
C. Samples: Submit two carpet tiles illustrating color and pattern design for each carpet color selected.
D. Concrete Subfloor Test Report: Submit a copy of the moisture and alkalinity (pH) test reports.
E. Operation and Maintenance Data: Include maintenance procedures, recommended maintenance materials, and suggested schedule for cleaning.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
2. Extra Carpet Tiles: Quantity equal to 5 percent of total installed of each color and pattern installed.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing specified carpet tile with minimum ten years documented experience.
B. Installer Qualifications: Company specializing in installing carpet tile with minimum three years documented experience and approved by carpet tile manufacturer.

1.06 FIELD CONDITIONS
A. Store materials in area of installation for minimum period of 24 hours prior to installation.
B. Maintain minimum 70 degrees F ambient temperature 24 hours prior to, during and 24 hours after installation.
C. Ventilate installation area during installation and for 72 hours after installation.

PART 2 PRODUCTS
2.01 MANUFACTURERS
A. Tile Carpeting:
   1. Mannington Commercial: www.manningtoncommercial.com
   3. Tarkett: https://commercial.tarkett.com/
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MATERIALS
A. Tile Carpeting, Type _____: Tufted, manufactured in one color dye lot.
   2. Tile Size: 24" by 24" inch, nominal.
   3. Color: Refer to drawings.
   4. Pattern: Refer to drawings.

2.03 ACCESSORIES
A. Subfloor Filler: White premix latex; type recommended by flooring material manufacturer.
B. Edge Strips: Rubber, Architect to select color.
C. Adhesives:
   1. Compatible with materials being adhered; maximum VOC content as specified in Section 01 61 16.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that subfloor surfaces are smooth and flat within tolerances specified for that type of work and are ready to receive carpet tile.
B. Verify that wall surfaces are smooth and flat within the tolerances specified for that type of work, are dust-free, and are ready to receive carpet tile.
C. Cementitious Subfloor Surfaces: Verify that substrates are ready for flooring installation by testing for moisture and alkalinity (pH).
   1. Obtain instructions if test results are not within limits recommended by flooring material manufacturer and adhesive materials manufacturer.

3.02 PREPARATION
A. Remove existing carpet tile.
B. Prepare floor substrates for installation of flooring in accordance with Section 09 05 61.
3.03 INSTALLATION

A. Starting installation constitutes acceptance of subfloor conditions.
B. Install carpet tile in accordance with manufacturer’s instructions.
C. Blend carpet from different cartons to ensure minimal variation in color match.
D. Cut carpet tile clean. Fit carpet tight to intersection with vertical surfaces without gaps.
E. Lay carpet tile in square pattern, with pile direction parallel to next unit, set parallel to building lines.
F. Trim carpet tile neatly at walls and around interruptions.
G. Complete installation of edge strips, concealing exposed edges.

3.04 CLEANING

A. Remove excess adhesive without damage, from floor, base, and wall surfaces.
B. Clean and vacuum carpet surfaces.

END OF SECTION
SECTION 09 90 00
PAINTS AND COATINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Surface preparation.
   B. Field application of paints and other coatings.
   C. Scope: Finish all interior and exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.
      1. Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
      2. Exposed surfaces of steel lintels and ledge angles.
      3. Mechanical and Electrical:
         a. In finished areas, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
         b. In finished areas, paint shop-primed items.
   D. Do Not Paint or Finish the Following Items:
      1. Items fully factory-finished unless specifically so indicated; materials and products having factory-applied primers are not considered factory finished.
      2. Items indicated to receive other finishes.
      3. Items indicated to remain unfinished.
      4. Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
      5. Stainless steel, anodized aluminum, bronze, terne, and lead items.
      6. Floors, unless specifically so indicated.
      7. Glass.
      8. Acoustical materials, unless specifically so indicated.
      9. Concealed pipes, ducts, and conduits.
   E. Painting materials and methods for conduit identification specified in Section 26 05 53.

1.02 RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B. Section 01 78 39 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.

1.03 REFERENCE STANDARDS
   C. NACE (IMP) - Industrial Maintenance Painting; NACE International; Edition date unknown.
   D. SSPC (PM1) - Good Painting Practice: SSPC Painting Manual, Vol. 1; Society for Protective Coatings.

1.04 DEFINITIONS
   A. Conform to ASTM D 16 for interpretation of terms used in this section.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 33 00 - Submittal Procedures.
C. Product Data: Provide data on all finishing products and special coatings, including VOC content.
D. Samples: Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded. Submit on paper draw down, 8 x 11 inch in size.
E. Certification: By manufacturer that all paints and coatings comply with VOC limits specified.
F. Manufacturer’s Instructions: Indicate special surface preparation procedures and substrate conditions requiring special attention.
G. Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified, with minimum ten years documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified with minimum five years experience.

1.07 REGULATORY REQUIREMENTS
A. Conform to applicable code for flame and smoke rating requirements for products and finishes.

1.08 MOCK-UP
A. See Section 01 40 00 - Quality Requirements, for general requirements for mock-up.
B. Provide panel, 10 feet long by 8 feet wide, illustrating coating color, texture, and finish.
C. Provide door and frame assembly illustrating coating color, texture, and finish.
D. Locate where directed.
E. Mock-up may remain as part of the work.

1.09 DELIVERY, STORAGE, AND HANDLING
A. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.
B. Container Label: Include manufacturer’s name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.
C. Paint Materials: Store at minimum ambient temperature of 45 degrees F and a maximum of 90 degrees F, in ventilated area, and as required by manufacturer’s instructions.

1.10 FIELD CONDITIONS
A. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the paint product manufacturer.
B. Follow manufacturer’s recommended procedures for producing best results, including testing of substrates, moisture in substrates, and humidity and temperature limitations.
C. Minimum Application Temperatures for Latex Paints: 45 degrees F for interiors; 50 degrees F for exterior; unless required otherwise by manufacturer’s instructions.
D. Minimum Application Temperature for Varnish Finishes: 65 degrees F for interior or exterior, unless required otherwise by manufacturer's instructions.
E. Provide lighting level of 80 ft candles measured mid-height at substrate surface.
1.11 EXTRA MATERIALS
   A. See Section 01 60 00 - Product Requirements, for additional provisions.
   B. Supply 1 gallon of each color; store where directed.
   C. Label each container with color, type, texture, and room locations in addition to the manufacturer's label.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Provide all paint and coating products used in any individual system from the same manufacturer; no exceptions.
   B. Paints:
      1. ICI Paints North America: www.icipaints.com
   C. Field-Catalyzed Coatings:
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 PAINTS AND COATINGS - GENERAL
   A. Paints and Coatings: Ready mixed, unless intended to be a field-catalyzed coating.
      1. Provide paints and coatings of a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating, with good flow and brushing properties, and capable of drying or curing free of streaks or sags.
      2. For opaque finishes, tint each coat including primer coat and intermediate coats, one-half shade lighter than succeeding coat, with final finish coat as base color.
      3. Supply each coating material in quantity required to complete entire project's work from a single production run.
      4. Do not reduce, thin, or dilute coatings or add materials to coatings unless such procedure is specifically described in manufacturer's product instructions.
   B. Primers: Where the manufacturer offers options on primers for a particular substrate, use primer categorized as "best" by the manufacturer.
   C. Volatile Organic Compound (VOC) Content: Comply with Section 01 61 16.
   D. Chemical Content: The following compounds are prohibited:
      1. Aromatic Compounds: In excess of 1.0 percent by weight of total aromatic compounds (hydrocarbon compounds containing one or more benzene rings).
      2. Acrolein, acrylonitrile, antimy, benzene, butyl benzyl phthalate, cadmium, di(2-ethylhexyl) phthalate, di-n-butyl phthalate, di-n-octyl phthalate, 1,2-dichlorobenzene, diethyl phthalate, dimethyl phthalate, ethylbenzene, formaldehyde, hexavalent chromium, isophorone, lead, mercury, methyl ethyl ketone, methyl isobutyl ketone, methylene chloride, naphthalene, toluene (methylbenzene), 1,1,1-trichloroethane, vinyl chloride.
   E. Colors: To be selected from manufacturer's full range of available colors.
      1. Allow for minimum of three colors for each system, unless otherwise indicated, without additional cost to Owner.

2.03 PAINT SYSTEMS - INTERIOR
   A. Paint I-OP - All Interior Surfaces Indicated to be Painted, Unless Otherwise Indicated:
      Including gypsum board, concrete, concrete masonry, brick, wood, plaster, uncoated steel, shop primed steel, galvanized steel, and aluminum.
      1. Two top coats and one coat primer.
2. Top Coat(s): Institutional Low Odor/VOC Interior Latex; MPI #143-148.
3. Eggshell: MPI gloss level 3; use this sheen at all locations.
4. Top Coat Product(s):
   a. Sherwin-Williams ProMar 200 Zero VOC Interior Latex. (MPI #43, 44, 52, 54, 144)
5. Primer(s): As recommended by manufacturer of top coats.

B. Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:
1. Two top coats and one coat primer.
2. Eggshell: MPI gloss level 3; use this sheen at all locations.
3. Top Coat Product(s):

1. Applications: At Toilet Rooms and at operable plumbing walls.
2. Two top coats and one coat primer.
3. Top Coat(s): Interior Epoxy-Modified Latex; MPI #115, 215.
4. Semi-Gloss: MPI gloss level 5; use this sheen at all locations.
5. Top Coat Product(s):
   a. Sherwin-Williams Waterbased Catalyzed Epoxy.
6. Primer(s): As recommended by manufacturer of top coats.

2.04 ACCESSORY MATERIALS
   A. Accessory Materials: Provide all primers, sealers, cleaning agents, cleaning cloths, sanding materials, and clean-up materials required to achieve the finishes specified whether specifically indicated or not; commercial quality.
   B. Patching Material: Latex filler.
   C. Fastener Head Cover Material: Latex filler.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces are ready to receive work as instructed by the product manufacturer.
   B. Examine surfaces scheduled to be finished prior to commencement of work. Report any condition that may potentially affect proper application.
   C. Test shop-applied primer for compatibility with subsequent cover materials.
   D. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following maximums:
      1. Gypsum Wallboard: 12 percent.
      2. Plaster and Stucco: 12 percent.
      3. Masonry, Concrete, and Concrete Unit Masonry: 12 percent.
      4. Interior Wood: 15 percent, measured in accordance with ASTM D4442.
      5. Concrete Floors and Traffic Surfaces: 8 percent.

3.02 PREPARATION
   A. Clean surfaces thoroughly and correct defects prior to coating application.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.
   C. Remove or mask surface appurtenances, including electrical plates, hardware, light fixture trim, escutcheons, and fittings, prior to preparing surfaces or finishing.
   D. Surfaces: Correct defects and clean surfaces which affect work of this section. Remove or repair existing coatings that exhibit surface defects.
E. Marks: Seal with shellac or stain blocker those which may bleed through surface finishes.

F. Remove mildew from impervious surfaces by scrubbing with solution of tetra-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

G. Concrete and Unit Masonry Surfaces to be Painted: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with a solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with a solution of sodium metasilicate after thoroughly wetting with water. Allow to dry.

H. Gypsum Board Surfaces to be Painted: Fill minor defects with filler compound. Spot prime defects after repair.

I. Insulated Coverings to be Painted: Remove dirt, grease, and oil from canvas and cotton.

J. Aluminum Surfaces to be Painted: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

K. Galvanized Surfaces to be Painted: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

L. Corroded Steel and Iron Surfaces to be Painted: Prepare using at least SSPC-PC 2 (hand tool cleaning) or SSPC-SP 3 (power tool cleaning) followed by SSPC-SP 1 (solvent cleaning).

M. Uncorroded Uncoated Steel and Iron Surfaces to be Painted: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by power tool wire brushing or sandblasting; clean by washing with solvent. Apply a treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Prime paint entire surface; spot prime after repairs.

N. Shop-Primed Steel Surfaces to be Finish Painted: Sand and scrape to remove loose primer and rust. Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Re-prime entire shop-primed item.

O. Interior Wood Surfaces to Receive Opaque Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats. Back stain concealed surfaces before installation.

P. Interior Wood Surfaces to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats. Prime concealed surfaces with gloss varnish reduced 25 percent with thinner.

Q. Exterior and Interior Wood to Receive Opaque Latex Stain Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior caulking compound after initial coat has been applied. Back stain concealed surfaces before installation.

R. Metal Doors to be Painted: Prime metal door top and bottom edge surfaces.

3.03 APPLICATION

A. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

B. Exterior Wood to Receive Opaque Finish: If final painting must be delayed more than 2 weeks after installation of woodwork, apply primer within 2 weeks and final coating within 4 weeks.

C. Apply products in accordance with manufacturer's instructions.

D. Where adjacent sealant is to be painted, do not apply finish coats until sealant is applied.

E. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.
F. Apply each coat to uniform appearance.

G. Dark Colors and Deep Clear Colors: Regardless of number of coats specified, apply as many coats as necessary for complete hide.

H. Sand wood and metal surfaces lightly between coats to achieve required finish.

I. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

J. Wood to Receive Transparent Finishes: Tint fillers to match wood. Work fillers into the grain before set. Wipe excess from surface.

K. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.04 FINISHING MECHANICAL AND ELECTRICAL EQUIPMENT

A. Refer to Section 22 05 53, Section 23 05 53 and Section 26 05 53 for schedule of color coding of equipment, duct work, piping, and conduit.

B. Paint shop-primed equipment, where indicated.

C. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.

D. Finish equipment, piping, conduit, and exposed duct work in utility areas in colors according to the color coding scheme indicated.

E. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

3.05 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for general requirements for field inspection.

3.06 CLEANING

A. Collect waste material that could constitute a fire hazard, place in closed metal containers, and remove daily from site.

3.07 PROTECTION

A. Protect finished coatings until completion of project.

B. Touch-up damaged coatings after Substantial Completion.

3.08 SCHEDULE - SURFACES TO BE FINISHED

A. Do Not Paint or Finish the Following Items:
   1. Items fully factory-finished unless specifically noted.
   2. Fire rating labels, equipment serial number and capacity labels.
   3. Stainless steel items.

B. Paint the surfaces described below under Schedule - Paint Systems.

C. Mechanical and Electrical: Use paint systems defined for the substrates to be finished.
   1. Where indicated as exposed, paint all insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment occurring in finished areas to match background surfaces.
   2. Paint all equipment, including that which is factory-finished, exposed to weather or to view on the roof and outdoors.
   3. Paint shop-primed items occurring in finished areas.
   4. Paint interior surfaces of air ducts and convectors and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
5. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

D. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.

3.09 SCHEDULE - COLORS

A. See Plans and Schedule for locations

END OF SECTION
SECTION 10 11 01
VISUAL DISPLAY BOARDS

PART 1  GENERAL

1.01  SECTION INCLUDES
   A. Tackboards.
   B. Magnetic Markerboards and Tackboards.
   C. Tackboards.

1.02  RELATED REQUIREMENTS
   A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions.
   B. Section 01 74 19 - Construction Waste Management and Disposal: Limitations on disposal of removed materials; requirements for recycling.
   C. Section 06 10 00 - Rough Carpentry: Blocking and supports.
   D. Section 09 21 16 - Gypsum Board Assemblies: Concealed supports in metal stud walls.

1.03  REFERENCE STANDARDS
   A. ANSI A135.4 - Basic Hardboard.
   F. ASTM F793/F793M - Standard Classification of Wall Coverings by Use Characteristics.

1.04  SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer's data on markerboard, tackboard, trim, and accessories.
   C. Shop Drawings: Indicate wall elevations, dimensions, joint locations, special anchor details.
   D. Samples: Submit two samples 6 by 6 inch in size illustrating materials and finish, color and texture of markerboard, tackboard, and trim.
   E. Test Reports: Show conformance to specified surface burning characteristics requirements.
   F. Manufacturer's printed installation instructions.
   G. Maintenance Data: Include data on regular cleaning, and stain removal.

1.05  QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.

1.06  WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year warranty for markerboard to include warranty against discoloration due to cleaning, crazing or cracking, and staining.

PART 2  PRODUCTS

2.01  MANUFACTURERS

D. Substitutions: See Section 01 60 00 - Product Requirements.

E. Visual Display Boards - Basis of Design:
   1. Claridge Products and Equipment, Inc; Product Marker Board - Claridge LCS Deluxe;
      Tackboard - Claridge AC Series: www.claridgeproducts.com/#sle.
   2. Aarco Products, Inc.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 VISUAL DISPLAY BOARDS

A. Magnetic Markerboards: Porcelain enamel on steel, laminated to core.
   2. Metal Face Sheet Thickness: 0.024 inch (24 gage).
   4. Backing: Aluminum sheet, laminated to core.
   5. Size: As indicated on drawings.
   7. Frame Profile: Standard
   9. Accessories: Provide chalk tray, map rail, flag holder, and map hooks.
   10. Magnetic.

B. Tackboards: Composition cork.
   2. Color: As selected from manufacturer's full range.
   3. Backing: Hardboard, 1/4 inch thick, laminated to tack surface.
   4. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84.
   5. Size: As indicated on drawings.

2.03 MATERIALS

A. Porcelain Enamed Steel Sheet: ASTM A424, Type I, Commercial Steel, with fired-on vitreous finish.

B. Particleboard: ANSI A208.1; wood chips, set with waterproof resin binder, sanded faces.

C. Aluminum Sheet Backing: 0.015 inch thick.

2.04 ACCESSORIES

A. Map Rail: Extruded aluminum, manufacturer's standard profile, with cork insert, end stops, and runners for accessories; 1 inch wide, full width of frame.

B. Map Supports: Formed aluminum sliding hooks to fit map rail. "One support per two feet of map rail."

C. Temporary Protective Cover: Sheet polyethylene, 8 mil thick.

D. Cleaning Instruction Plate: Provide instructions for chalkboard cleaning on a metal plate fastened to perimeter frame near chalkrail.

E. Marker Tray: Aluminum, manufacturer's standard extruded profile closed ends; concealed fasteners,; manufacturer's standard fastening method, same finish as frame.

F. Mounting Brackets: Concealed.
PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as indicated and indicated on shop drawings.
   B. Verify that internal wall blocking is ready to receive work and positioning dimensions are as indicated on shop drawings.

3.02 INSTALLATION
   A. Install boards in accordance with manufacturer's instructions. Mounting height per drawings.
   B. Secure units level and plumb.
   C. Butt Joints: Install with tight hairline joints.

3.03 CLEANING
   A. Clean board surfaces in accordance with manufacturer's instructions.
   B. Cover with protective cover, taped to frame.
   C. Remove temporary protective cover at date of Substantial Completion.

END OF SECTION
SECTION 10 14 00
SIGNAGE

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Room and door signs.

1.02  RELATED REQUIREMENTS
A. Section 26 05 53 - Identification for Electrical Systems.

1.03  REFERENCE STANDARDS
B. ADA Standards - 2010 ADA Standards for Accessible Design.

1.04  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Manufacturer's printed product literature for each type of sign, indicating sign styles, font, foreground and background colors, locations, overall dimensions of each sign.
C. Signage Schedule: Provide information sufficient to completely define each sign for fabrication, including room number, room name, other text to be applied, sign and letter sizes, fonts, and colors.
   1. When room numbers to appear on signs differ from those on drawings, include the drawing room number on schedule.
   2. When content of signs is indicated to be determined later, request such information from Owner through Architect at least 2 months prior to start of fabrication; upon request, submit preliminary schedule.
   3. Submit for approval by Owner through Architect prior to fabrication.
D. Samples: Submit two samples of each type of sign, of size similar to that required for project, illustrating sign style, font, and method of attachment.
E. Selection Samples: Where colors are not specified, submit two sets of color selection charts or chips.
F. Verification Samples: Submit samples showing colors specified.

1.05  QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum five years of documented experience.

1.06  DELIVERY, STORAGE, AND HANDLING
A. Package signs as required to prevent damage before installation.
B. Package room and door signs in sequential order of installation, labeled by floor or building.
C. Store tape adhesive at normal room temperature.

1.07  FIELD CONDITIONS
A. Do not install tape adhesive when ambient temperature is lower than recommended by manufacturer.
B. Maintain this minimum temperature during and after installation of signs.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Flat Signs:
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SIGNAGE APPLICATIONS

A. Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

B. Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.
   1. Sign Type: Flat signs with engraved panel media as specified.
   2. Provide "tactile" signage, with letters raised minimum 1/32 inch and Grade II braille.
   3. Character Height: 1 inch.
   4. Sign Height: 2 inches, unless otherwise indicated.
   5. Office Doors: Identify with room numbers to be determined later, not the numbers shown on the drawings; in addition, provide "window" section for replaceable occupant name.
   6. Conference and Meeting Rooms: Identify with room numbers to be determined later, not the numbers shown on the drawings.
   7. Service Rooms: Identify with room names and numbers to be determined later, not those shown on the drawings.
   8. Rest Rooms: Identify with pictograms, the names "MEN" and "WOMEN", and braille.

C. Building Identification Signs:
   1. Use individual brushed aluminum letters.
   2. Mount on outside wall in location indicated on drawings.

2.03 SIGN TYPES

A. Flat Signs: Signage media without frame.
   1. Edges: Square.
   2. Corners: Radiused.
   3. Provide a blank rear plate at signage installed on glass.

B. Color and Font: Unless otherwise indicated:
   1. Character Font: Helvetica, Arial, or other sans serif font.
   2. Character Case: Upper case only.

2.04 TACTILE SIGNAGE MEDIA

A. Engraved Panels: Laminated colored plastic; engraved through face to expose core as background color.
   1. Total Thickness: 1/16 inch.
2.05 ACCESSORIES
   A. Concealed Screws: Stainless steel, galvanized steel, chrome plated, or other non-corroding metal.
   B. Tape Adhesive: Double sided tape, permanent adhesive.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that substrate surfaces are ready to receive work.

3.02 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Install neatly, with horizontal edges level.
   C. Locate signs where indicated:
      1. Room and Door Signs: Locate on wall at latch side of door with centerline of sign at 60 inches above finished floor.
      2. If no location is indicated obtain Owner's instructions.
   D. Protect from damage until Substantial Completion; repair or replace damage items.
   E. When flat sign must be glass mounted, provide blank sign for other side of glass to cover tape adhesive.

END OF SECTION
SECTION 10 21 23
CUBICLE CURTAINS AND TRACK

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Surface mounted overhead curtain track and guides.
B. Cubicle curtains.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for curtain fabric characteristics and curtain track.
C. Shop Drawings: Indicate a reflected ceiling plan view of curtain track, hangers and suspension points, attachment details, schedule of curtain sizes.
D. Samples: Submit 12 by 12 inch sample patch of curtain cloth with representative top, bottom, and edge hem stitch detail, heading with reinforcement and carrier attachment to curtain header.
E. Samples: Submit 12 inch sample length of curtain track including typical splice, wall and ceiling hanger, and escutcheon.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Cubicle Track and Curtains:
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 TRACKS AND TRACK COMPONENTS
A. Tracks: Extruded aluminum sections; one piece per track run.
   1. Profile: Channel.
   3. Track End Stop: To fit track section.
B. Curtain Carriers: Nylon rollers, size and type compatible with track; designed to eliminate bind when curtain is pulled; fitted to curtain to prevent accidental curtain removal.
C. Installation Accessories: Types required for specified mounting method and substrate conditions.

2.03 CURTAINS
A. Cubicle Curtains:
   1. Material: Close weave polyester; anti-bacterial, self deodorizing, sanitized, and preshrunk.
   2. Color/Pattern: To be selected by Architect.
   3. Open Mesh Cloth: Open weave to permit air circulation; flameproof material, manufacturer's standard color.
4. Attachment of Curtain Fabric to Open Mesh Cloth: Manufacturer's standard sewn seam.

B. Curtain Fabrication:
   1. Width of curtain to be 10 percent wider than track length.
   2. Include open mesh cloth at top 20 inches of curtain for room air circulation, attached to curtain as specified above.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that surfaces and supports above ceiling are ready to receive work of this Section.

3.02 INSTALLATION
   A. Install curtain track to be secure, rigid, and true to ceiling line.
   B. Secure track to ceiling system.
   C. Install curtains on carriers ensuring smooth operation.

3.03 SCHEDULES
   A. See drawings for location.

END OF SECTION
SECTION 10 28 00
TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Commercial toilet accessories.
B. Under-lavatory pipe supply covers.

1.02 RELATED REQUIREMENTS
A. Section 06 10 00: Concealed supports for accessories, including in wall framing and plates.

1.03 REFERENCE STANDARDS
A. ADA Standards - 2010 ADA Standards for Accessible Design.
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordinate the work with the placement of internal wall reinforcement, concealed ceiling supports, and reinforcement of toilet partitions to receive anchor attachments.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. See Section 01 33 00 - Submittal Procedures.
C. Product Data: Submit data on accessories describing size, finish, details of function, and attachment methods.
D. Schedule: Submit schedule indicating accessories, quantity and location.
E. Manufacturer's Installation Instructions: Indicate special procedures and conditions requiring special attention.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Commercial Toilet, Shower, and Bath Accessories:
   2. Bobrick Washroom Equipment, Inc: www.bobrick.com
   4. Substitutions: Section 01 60 00 - Product Requirements.
B. Under-Lavatory Pipe Supply Covers:
   1. ISP Corporation: Trubro, Lav Guard 2.
   2. Substitutions: Section 01 60 00 - Product Requirements.
2.02 MATERIALS
   A. Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.
   B. Stainless Steel Sheet: ASTM A666, Type 304.
   C. Stainless Steel Tubing: ASTM A269/A269M, Grade TP304 or TP316.

2.03 FINISHES
   A. Stainless Steel: Satin finish, unless otherwise noted.

2.04 COMMERCIAL TOILET ACCESSORIES
   A. Refer to Schedule on Drawings.

2.05 UNDER-LAVATORY PIPE AND SUPPLY COVERS
   A. Under-Lavatory Pipe and Supply Covers:
      1. Insulate exposed drainage piping including hot, cold, and tempered water supplies under lavatories or sinks to comply with ADA Standards.
      2. Construction: 1/8 inch flexible PVC.
      4. Fasteners: Reusable, snap-locking fasteners with no sharp or abrasive external surfaces.
      5. Products:
         a. ISP Corporation: Trubro, Lav Guard 2.
         b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify existing conditions before starting work.
   B. Verify exact location of accessories for installation.
   C. See Section 06 10 00 - Rough Carpentry for installation of blocking, reinforcing plates, and concealed anchors in walls and ceilings.

3.02 INSTALLATION
   A. Install accessories in accordance with manufacturers’ instructions in locations indicated on drawings.
   B. Install plumb and level, securely and rigidly anchored to substrate.
   C. Mounting Heights: As required by accessibility regulations, unless otherwise indicated.

3.03 PROTECTION
   A. Protect installed accessories from damage due to subsequent construction operations.

END OF SECTION
SECTION 10 44 00
FIRE PROTECTION SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Fire extinguishers.
B. Fire extinguisher cabinets.
C. Accessories.

1.02 RELATED REQUIREMENTS
A. Section 06 10 00 - Rough Carpentry: Wood blocking product and execution requirements.

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Fire extinguishers and cabinets.
C. Shop Drawings: Indicate locations of cabinets and cabinet physical dimensions.
D. Manufacturer's Installation Instructions: Indicate special criteria and wall opening coordination requirements.
E. Maintenance Data: Include test, refill or recharge schedules and re-certification requirements.

1.04 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum 10 years documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Fire Extinguishers:
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Fire Extinguisher Cabinets and Accessories:
   5. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 FIRE EXTINGUISHERS
A. Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.
B. Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gage.
   1. Class: 3A 40B:C type.
   2. Size: 5 pound nominal capacity.

2.03 FIRE EXTINGUISHER CABINETS
A. Cabinet Construction: Non-fire rated.
B. Cabinet Configuration: Semi-recessed type.
   1. Size to accommodate accessories.
D. Door Glazing: Acrylic plastic, clear, 1/8 inch thick, flat shape and set in resilient channel glazing gasket.
E. Finish of Cabinet Exterior Trim and Door: Baked enamel, white color.
F. Finish of Cabinet Interior: White colored enamel.

2.04 ACCESSORIES
A. Extinguisher Brackets: Formed steel, chrome-plated.
B. Cabinet Signage: On cabinet door.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify rough openings for cabinet are correctly sized and located.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Secure rigidly in place.
C. Place extinguishers in cabinets.

3.03 MAINTENANCE
A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.

END OF SECTION
PART 1 GENERAL

SECTION INCLUDES

A. Interior manual roller shades.

RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Concealed wood blocking for attachment of headrail brackets.

ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Convene one week prior to commencing work related to products of this section; require attendance of affected installers.
B. Sequencing:
   1. Do not fabricate shades until field dimensions for each opening have been taken with field conditions in place.
   2. Do not install shades until final surface finishes and painting are complete.

SUBMITTALS

A. See Section 01 33 00 - Submittal Procedures, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets, including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
C. Shop Drawings: Include shade schedule indicating size, location and keys to details, head, jamb and sill details, mounting dimension requirements for each product and condition, and operation direction.
D. Certificates: Manufacturer's documentation that line voltage components are UL listed or UL recognized.
E. Source Quality Control Submittals: Provide test reports indicating compliance with specified fabric properties.
F. Selection Samples: Include fabric samples in full range of available colors and patterns.
G. Verification Samples: Minimum size 6 inches square, representing actual materials, color and pattern.
H. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.
I. Project Record Documents: Record actual locations of control systems and show interconnecting wiring.
J. Operation and Maintenance Data: List of all components with part numbers, sources of supply, and operation and maintenance instructions; include copy of shop drawings.
K. Warranty: Submit sample of manufacturer's warranty and documentation of final executed warranty completed in Owner's name and registered with manufacturer.
L. Maintenance contracts.

QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than ten years of documented experience.
B. Installer Qualifications: Company specializing in performing work of this type with minimum five years of documented experience with shading systems of similar size and type.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
   B. Handle and store shades in accordance with manufacturer's recommendations.

1.07 FIELD CONDITIONS
   A. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide manufacturer's warranty from Date of Substantial Completion, covering the following:
      1. Shade Hardware: 25 years.
      2. Fabric: 25 years.
      3. Aluminum and Steel Coatings: One year.
      4. Shade Installation: 2 years

PART 2 PRODUCTS
2.01 MANUFACTURERS
   A. Interior Manually Operated Roller Shades:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 ROLLER SHADES
   A. General:
      1. Provide shade system components that are easy to remove or adjust without removal of mounted shade brackets.
      2. Provide shade system that operates smoothly when shades are raised or lowered.
   B. Roller Shades Type 1 - Basis of Design: MechoShade Systems LLC; Mecho/5 System; www.mechoshade.com/#sle.
      1. Description: Single roller, manually operated fabric window shades.
         a. Drop Position: Regular roll.
         b. Mounting: Ceiling mounted.
         c. Fabric: As indicated under Shade Fabric article.
      2. Brackets and Mounting Hardware: As recommended by manufacturer for mounting indicated and to accommodate shade fabric roll-up size and weight.
      3. Roller Tubes:
         b. Size: As recommended by manufacturer; selected for suitability for installation conditions, span, and weight of shades.
         c. Fabric Attachment: Utilize extruded channel in tube to accept vinyl spline welded to fabric edge. Shade band to be removable and replaceable without removing roller tube from brackets or inserting spline from the side of the roller tube.
         d. Roller tubes to be capable of being removed and reinstalled without affecting roller shade limit adjustments.
      4. Hembars: Designed to maintain bottom of shade straight and flat.
5. **Clutch Operator:** Manufacturer's standard material and design integrated with bracket/brake assembly.
   a. Provide a permanently lubricated brake assembly mounted on an oil-impregnated hub with wrapped spring clutch.
   b. Brake must withstand minimum pull force of 50 pounds in the stopped position.
   c. Mount clutch/brake assembly on the support brackets, fully independent of the roller tube components.

6. **Drive Chain:** Continuous loop stainless steel beaded ball chain, 95 pound minimum breaking strength. Provide upper and lower limit stops.
   a. **Chain Retainer:** Chain tensioning device complying with WCMA A100.1.

7. **Accessories:**
   a. **Fascia:** Extruded aluminum, size as required to conceal shade mounting, attachable to brackets without exposed fasteners; clear anodized finish.
      1) **Profile:** Square.
      2) **Configuration:** Continuous, fascia extends past continuous bracket.
   b. **Fasteners:** Noncorrosive, and as recommended by shade manufacturer.

### 2.03 SHADE FABRIC

**A.** Fabric for Light-Filtering Shades: Nonflammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.

1. **Manufacturers:**
   b. **Substitutions:** See Section 01 60 00 - Product Requirements.

2. **Material:** Vinyl coated polyester.

3. **Performance Requirements:**
   a. **Flammability:** Pass NFPA 701 large and small tests.
   b. **Fungal Resistance:** No growth when tested according to ASTM G21.

4. **Openness Factor:** 5%.

5. **Color:** As selected by Architect from manufacturer’s full range of colors.

### 2.04 ROLLER SHADE FABRICATION

**A.** Field measure finished openings prior to ordering or fabrication.

**B.** Dimensional Tolerances: Fabricate shades to fit openings within specified tolerances.

1. **Vertical Dimensions:** Fill openings from head to sill with 1/2 inch space between bottom bar and window stool.

2. **Horizontal Dimensions - Inside Mounting:** Fill openings from jamb to jamb.

**C.** At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

### PART 3 EXECUTION

### 3.01 EXAMINATION

**A.** Examine finished openings for deficiencies that may preclude satisfactory installation.

**B.** Start of installation shall be considered acceptance of substrates.

### 3.02 INSTALLATION

**A.** Install in accordance with manufacturer's instructions and approved shop drawings, using mounting devices as indicated.

**B.** Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.

**C.** Adjust level, projection, and shade centering from mounting bracket. Verify there is no telescoping of shade fabric. Ensure smooth shade operation.
3.03 CLEANING
   A. Clean soiled shades and exposed components as recommended by manufacturer.
   B. Replace shades that cannot be cleaned to "like new" condition.
   C. See Section 01 74 19 - Construction Waste Management and Disposal for additional requirements.

3.04 CLOSEOUT ACTIVITIES
   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

3.05 PROTECTION
   A. Protect installed products from subsequent construction operations.
   B. Touch-up, repair, or replace damaged products before Substantial Completion.

3.06 MAINTENANCE
   A. See Section 01 70 00 - Execution and Closeout Requirements, for additional requirements relating to maintenance service.
   B. Provide to Owner, a proposal as an alternate to the base bid, a separate renewable maintenance contract for the service and maintenance of a motorized shade system for one year from date of Substantial Completion. Include a complete description of preventive maintenance, systematic examination, adjustment, parts and labor, cleaning, and testing, with a detailed schedule.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Above ground piping.
B. Pipe, fittings, valves, and connections for sprinkler, standpipe and fire hose, and combination sprinkler and standpipe systems.
C. Pipe hangers and supports.

1.02 RELATED REQUIREMENTS

A. Section 09 90 00 - Painting and Coating: Preparation and painting of fire protection piping systems.
B. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment: Piping identification.
C. Section 22 05 53 - Identification for Plumbing Piping and Equipment: Piping identification.
D. Section - Fire-Suppression Sprinkler Systems: Sprinkler systems design.
E. Section - Fire-Suppression Standpipes: Standpipe design.

1.03 REFERENCE STANDARDS

A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
E. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
G. ASME B16.11 - Forged Fittings, Socket-Welding and Threaded.
H. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
I. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
J. ASME B16.25 - Buttwelding Ends.
K. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
V. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).
AA. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
AB. AWS D1.1/D1.1M - Structural Welding Code - Steel.
AC. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
AE. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
AF. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
AH. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
AJ. UL (DIR) - Online Certifications Directory.
AK. UL 262 - Gate Valves for Fire-Protection Service; Underwriters Laboratories Inc..
AL. UL 312 - Check Valves for Fire-Protection Service; Underwriters Laboratories Inc.

1.04 SUBMITTALS
B. Project Record Documents: Record actual locations of components and tag numbering.
C. Operation and Maintenance Data: Include installation instructions and spare parts lists.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience. approved by manufacturer.
C. Conform to UL requirements.
D. Valves: Bear UL label or marking. Provide manufacturer's name and pressure rating marked on valve body.
E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store valves in shipping containers, with labeling in place.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

1.07 EXTRA MATERIALS
A. See Gilbane Project Manual.
B. Provide two valve stem packings for each size and type of valve installed.

PART 2 PRODUCTS

2.01 FIRE PROTECTION SYSTEMS
A. Sprinkler Systems: Conform work to NFPA 13.
B. Standpipe and Hose Systems: Conform to NFPA 14.
C. Welding Materials and Procedures: Conform to ASME Code.

2.02 ABOVE GROUND PIPING
A. Steel Pipe: ASTM A795 Schedule 10 or ASTM A53 Schedule 40, black.
   4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
   5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.
B. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), H58 drawn.
   1. Fittings: ASME B16.18, cast copper alloy, grooved.
   2. Mechanical Grooved Couplings: Ductile iron housing with alkyd enamel paint coating clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers.
   3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.03 PIPE HANGERS AND SUPPORTS
A. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
B. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
C. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
D. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
E. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
F. Vertical Support: Steel riser clamp.
G. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
H. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
2.04 GATE VALVES
   A. Up to and including 2 inches:
      1. Bronze body, bronze trim, rising stem, handwheel, solid wedge or disc, threaded ends.
   B. Over 2 inches:
      1. Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, handwheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged ends.
   C. Over 4 inches:
      1. Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

2.05 GLOBE VALVES
   A. Up to and including 2 inches:
      1. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity repackable under pressure.
   B. Over 2 inches:
      1. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

2.06 BALL VALVES
   A. Up to and including 2 inches:
      1. Bronze two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle and balancing stops, threaded ends.
   B. Over 2 inches:
      1. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

2.07 BUTTERFLY VALVES
   A. Bronze Body:
      1. Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamper proof switch rated 10 amp at 115 volt AC.
   B. Cast or Ductile Iron Body
      1. Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and internal tamper switch rated 10 amp at 115 volt AC.

2.08 CHECK VALVES
   A. Up to and including 2 inches:
      1. Bronze body and swing disc, rubber seat, threaded ends.
   B. Over 2 inches:
      1. Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.
   C. 4 inches and Over:
      1. Iron body, bronze disc, stainless steel spring, resilient seat, threaded, wafer, or flanged ends.

2.09 DRAIN VALVES
   A. Compression Stop:
      1. Bronze with hose thread nipple and cap.
B. Ball Valve:

PART 3 EXECUTION

3.01 PREPARATION
A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and foreign material, from inside and outside, before assembly.
C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION
A. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
B. Install standpipe piping, hangers, and supports in accordance with NFPA 14.
C. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
D. Install piping to conserve building space, to not interfere with use of space and other work.
E. Group piping whenever practical at common elevations.
F. Sleeve pipes passing through partitions, walls, and floors.
G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
H. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
I. Pipe Hangers and Supports:
   1. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   2. Place hangers within 12 inches of each horizontal elbow.
   3. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   6. Provide copper plated hangers and supports for copper piping.
   7. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.
L. Do not penetrate building structural members unless indicated.
M. Provide sleeves when penetrating footings, floors, and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

N. Escutcheons:
   1. Install and firmly attach escutcheons at piping penetrations into finished spaces.
   2. Provide escutcheons on both sides of partitions separating finished areas through which piping passes.
   3. Use chrome plated escutcheons in occupied spaces and to conceal openings in construction.

O. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

P. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

Q. Install valves with stems upright or horizontal, not inverted. Remove protective coatings after installation.

R. Provide gate, ball, or butterfly valves for shut-off or isolating service.

S. Provide drain valves at main shut-off valves, low points of piping and apparatus.

END OF SECTION
SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Pipe Markers.

1.02 RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating: Identification painting.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
C. Product Data: Provide manufacturers catalog literature for each product required.
D. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
E. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
A. Control Panels: Nameplates.
B. Instrumentation: Tags.
C. Major Control Components: Nameplates.
D. Piping: Pipe markers.
E. Valves: Nameplates and ceiling tacks where above lay-in ceilings.

2.02 MANUFACTURERS
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 NAMEPLATES
A. Description: Laminated three-layer plastic with engraved letters.
   2. Letter Height: 1/4 inch.

2.04 TAGS
A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.
2.05 PIPE MARKERS
   B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around
      pipe or pipe covering; minimum information indicating flow direction arrow and identification of
      fluid being conveyed.
   C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing
      and printed markings.
   D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape,
      minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.06 CEILING TACKS
   A. Description: Steel with 3/4 inch diameter color coded head.

PART 3 EXECUTION

3.01 PREPARATION
   A. Degrease and clean surfaces to receive adhesive for identification materials.
   B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.02 INSTALLATION
   A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with
      sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
   B. Install tags with corrosion resistant chain.
   C. Apply stencil painting in accordance with Section 09 90 00.
   D. Install plastic pipe markers in accordance with manufacturer's instructions.
   E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's
      instructions.
   F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above
      buried pipe.
   G. Identify pumps and valves with plastic nameplates. Small devices, such as in-line pumps, may
      be identified with tags.
   H. Identify control panels and major control components outside panels with plastic nameplates.
   I. Identify thermostats relating to terminal boxes or valves with nameplates.
   J. Identify valves in main and branch piping with tags.
   K. Tag automatic controls, instruments, and relays. Key to control schematic.
   L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch
      diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and
      align with axis of piping. Locate identification not to exceed 20 feet on straight runs including
      risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or
      enclosure, and at each obstruction.
   M. Locate ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel
      closest to equipment.

END OF SECTION
SECTION 21 12 00
FIRE-SUPPRESSION STANDPIPES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Fire hose cabinets.
   B. Hose reels and hoses.
   C. Valves.
   D. Fire department connections.
   E. Fire extinguishers.

1.02 RELATED REQUIREMENTS
   A. Section 01 30 00 - Administrative Requirements: Submittal procedures, project meetings, progress schedules and documentation, reports, coordination.
   B. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance (O&M) data, warranties and bonds.
   C. Section 21 05 00 - Common Work Results for Fire Suppression: Fire protection piping.

1.03 REFERENCE STANDARDS
   A. FM (AG) - FM Approval Guide.
   B. ITS (DIR) - Directory of Listed Products.
   C. NFPA 10 - Standard for Portable Fire Extinguishers.
   D. NFPA 14 - Standard for the Installation of Standpipe and Hose Systems.
   E. UL (DIR) - Online Certifications Directory.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
   B. Product Data: Provide manufacturer's catalog sheet for equipment indicating rough-in size, finish, and accessories.
   C. Shop Drawings: Indicate supports, components, accessories, and sizes.
      1. Submit shop drawings and product data to Owner's insurance underwriter for approval.
      2. Submit proof of approval to Architect.
   D. Project Record Documents: Record actual locations of components.
   E. Operation Data: Include appropriate manufacturer's data.
   F. Maintenance Data: Include servicing requirements and test schedule.
   G. Certificates: Provide certificate of compliance from authority having jurisdiction indicating approval of field acceptance tests.

1.06 QUALITY ASSURANCE
   A. Perform Work in accordance with NFPA 14. Maintain one copy on site.
   B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years documented experience and approved by manufacturer.
1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver and store products in shipping packaging until installation.

1.08 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
   B. Correct defective Work within a two year period after Date of Substantial Completion.

PART 2 PRODUCTS

2.01 FIRE HOSE CABINETS
   A. Manufacturers:
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Cabinet:
      1. Style: Recessed mounted.
      2. Door: 12 gauge, 0.1046 inch thick steel, flush, glazed with 1/4 inch (6.35 mm) thick wired glass full panel; hinged, positive latch device.
   C. Hose Rack: Steel with polished chrome finish; swivel type with pins and water stop.
   D. Hose: 1 inch diameter, 50 feet long, of linen hose; mildew and rot-resistant.
   E. Nozzle: Chrome plated brass; combination fog, straight stream, and adjustable shut-off.

2.02 HOSE REELS AND HOSES
   A. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Construction:
      1. Red enameled hose reels, frames, and accessories suitable for hose length and diameter.
      2. Reels fitted with swivel and piping to allow continuous flow through hoses.
      3. Friction breaks to prevent hoses from accidental unwinding.
   C. Hoses:
      1. Construction: Flexible 3-braid, single-jacket, hard rubber or heavy duty synthetic red cover, non-collapsible, non-kinking, and fitted with couplings.
   D. Control Valve: 175 psi rated, quarter turn, ball for quick-opening operation.
   E. Hose Nozzle: 1-1/2 inch NPS chemical hose thread, polished brass, adjustable fog, off-and-on solid-stream type.

2.03 VALVES
   A. Specialty Valves:
      1. Hose Station Valve: Angle type, brass finish, 1-1/2 inch nominal size with automatic ball drip.
      2. Hose Connection Valve: Angle type; brass finish; 2-1/2 inch size, thread to match fire department hardware, 300 psi working pressure, with threaded cap and chain of same material and finish.
      3. Pressure Reducing Valve: Angle type; brass finish with inner hydraulic controls; 1-1/2 inch size, thread to match fire department hardware, 400 psi inlet pressure, with threaded cap and chain of same material and finish.
B. Hose Connection Valve Cabinets:
   1. Style: Recessed mounted.
   2. Tub: 16 gauge, 0.0598 inch thick steel, prepared for pipe and accessory rough-in.
   3. Door: 12 gauge, 0.1046 inch thick steel, flush, glazed with 1/4 inch (6.35 mm) thick wired glass full panel; hinged, positive latch device.

2.04 FIRE EXTINGUISHERS

A. General: Comply with NFPA 10; FM (AG), ITS (DIR), and UL (DIR) listed product.
B. Multi-Purpose Dry Chemical Type: Cartridge operated with hose and shut-off nozzle or integral shut-off nozzle.
   1. Manufacturers:
      b. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NFPA 14.
C. Locate and secure cabinets plumb and level. Establish top of cabinet (inside horizontal) surface 66 inches above finished floor.
D. Connect standpipe system to water source ahead of domestic water connection.
E. Flush entire system of foreign matter.

END OF SECTION
SECTION 21 13 00
FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Wet-pipe sprinkler system.
B. System design, installation, and certification.

1.02 RELATED REQUIREMENTS
A. Section 28 46 00 - Fire Detection and Alarm.
B. Section 21 05 00 - Common Work Results for Fire Suppression: Pipe, fittings, and valves.
C. Section 21 05 48 - Vibration and Seismic Controls for Fire Suppression Piping and Equipment.
D. Section 21 05 53 - Identification for Fire Suppression Piping and Equipment.
E. Section 21 30 00 - Fire Pumps.
F. Section 21 12 00 - Fire-Suppression Standpipes.
G. Section 14 91 00 - Facility Chutes: Sprinkler heads inside chutes.
H. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
I. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
J. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
A. FM P7825 - Approval Guide; Factory Mutual Research Corporation.
B. IT'S (DIR) - Directory of Listed Products.
E. UL (DIR) - Online Certifications Directory.

1.04 SUBMITTALS
A. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
B. Shop Drawings:
   1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
   2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
C. Samples: Submit one of each style of sprinkler specified.
D. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
E. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
F. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

G. Maintenance Materials: Furnish the following for Owner’s use in maintenance of project.
   1. Extra Sprinklers: Type and size matching those installed, in quantity required by referenced NFPA design and installation standard.
   2. Sprinkler Wrenches: For each sprinkler type.

1.05 QUALITY ASSURANCE

A. Maintain one copy of referenced design and installation standard on site.

B. Conform to UL requirements.

C. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

E. Installer Qualifications: Company specializing in performing the work of this section with minimum three years experience approved by manufacturer.

F. Equipment and Components: Provide products that bear UL label or marking.

G. Products Requiring Electrical Connection: Listed and classified by Underwriters’ Laboratories Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.06 MOCK-UP

A. Provide components for installation in mock-up.

B. Mock-up may not remain as part of the Work.

1.07 PRE-INSTALLATION MEETING

A. Convene one week before starting work of this section.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.09 EXTRA MATERIALS

A. Provide extra sprinklers of type and size matching those installed, in quantity required by referenced NFPA design and installation standard.

B. Provide suitable wrenches for each sprinkler type.

C. Provide metal storage cabinet located adjacent to alarm valve.

PART 2 PRODUCTS

2.01 SPRINKLER SYSTEM

A. Sprinkler System: Provide coverage for building areas noted.

B. Occupancy: comply with NFPA 13.

C. Water Supply: Determine volume and pressure from water flow test data.
   1. Revise design when test data available prior to submittals.

D. Interface system with building fire and smoke alarm system.

E. Provide fire department connections where indicated.
F. Storage Cabinet for Spare Sprinklers and Tools: Steel, located adjacent to alarm valve.

2.02 SPRINKLERS

A. Suspended Ceiling Type: Recessed-type, chrome-plated with push on, clamp, or screw type escutcheon plates.
   1. Finish: Chrome plated.
      a. Within Standard Acoustical Tile Ceilings: White with White Estucheon Plate
   2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
   3. Center in ceiling tile and provide with braided steel flexible hose.

B. Exposed Area Type: Standard upright type with guard.
   1. Finish: Chrome plated.
   2. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

C. Sidewall Type: Standard, Semi-recessed or Recessed horizontal sidewall type with matching push on escutcheon plate and guard.
   1. Finish: Chrome plated.
   2. Escutcheon Plate Finish: Chrome plated.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

D. Dry Sprinklers: Standard, Recessed or Exposed pendant type with matching push on escutcheon plate.
   1. Finish: Chrome plated.
   2. Escutcheon Plate Finish: Chrome plated.
   3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.

E. Guards: Finish to match sprinkler finish.

F. Spray Nozzles: Brass with solid cone discharge, 30 degrees of arc with blow-off dust cap.

2.03 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate water motor alarm and electric alarm, with pressure retard chamber and variable pressure trim; with test and drain valve.

B. Flooding Deluge Valve: Gate type valve with rubber faced disc actuated manually with water motor alarm and electric alarm, with alarm testing trim.

C. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy chrome plated gong and motor housing, nylon bearings, and inlet strainer.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with referenced NFPA design and installation standard.

B. Install equipment in accordance with manufacturer's instructions.

C. Place pipe runs to minimize obstruction to other work.

D. Place piping in concealed spaces above finished ceilings.

E. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.

F. 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.

G. Install and connect to fire pump system in accordance with Section 21 30 00.

H. Flush entire piping system of foreign matter.

I. Install guards on sprinklers where indicated.
J. Hydrostatically test entire system.
K. Require test be witnessed by Fire Marshal and authority having jurisdiction.

3.02 INTERFACE WITH OTHER PRODUCTS
A. Ensure required devices are installed and connected as required to fire alarm system.

END OF SECTION
SECTION 22 05 16
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Flexible pipe connectors.
B. Expansion joints and compensators.
C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS
A. Section 21 05 00 - Common Work Results for Fire Suppression.
B. Section 22 10 05 - Plumbing Piping.

1.03 REFERENCE STANDARDS
B. EJMA (STDS) - EJMA Standards.

1.04 SUBMITTALS
A. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
B. Design Data: Indicate selection calculations.
C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
D. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
E. Maintenance Data: Include adjustment instructions.

1.05 REGULATORY REQUIREMENTS
A. Conform to UL or Warnock Hersey requirements.

1.06 EXTRA MATERIALS
A. Supply two sets of packing for each packed expansion joint.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING
A. Manufacturers:
   3. Substitutions: See Section 01 60 00 - Product Requirements.
B. Inner Hose: Carbon Steel, Stainless Steel or Bronze.
C. Exterior Sleeve: Single braided or Double braided, stainless steel or bronze.
D. Exterior Sleeve: None.
E. Pressure Rating: 125 psi and 450 degrees F or 200 psi and 250 degrees F.
CCPS RFP# 23-10
EXPANSION FITTINGS AND LOOPS FOR
PLUMBING PIPING
Secure Entrances - Multiple Sites Project
Conowingo ES / Rising Sun ES

F. Joint: As specified for pipe joints.
G. Size: Use pipe sized units.
H. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING
A. Manufacturer:
   3. Substitutions: See Section 01 60 00 - Product Requirements.
B. Inner Hose: Bronze.
C. Exterior Sleeve: Braided bronze.
D. Pressure Rating: 125 psi and 450 degrees F or 200 psi and 250 degrees F.
E. Joint: As specified for pipe joints.
F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.
H. Application: Copper piping.

2.03 EXPANSION JOINTS - STEEL WITH PACKED SLIDING SLEEVE
A. Working Pressure and Temperature: Class 150 or Class 300.
B. Joint: As specified for pipe joints.
C. Size: Use pipe sized units.
D. Application: Steel piping 2 inches and over.

2.04 EXPANSION JOINTS - COPPER WITH PACKED SLIDING SLEEVE
A. Working Pressure: 125 psi.
B. Maximum Temperature: 250 degrees F.
C. Joint: As specified for pipe joints.
D. Size: Use pipe sized units.
E. Application: Copper or steel piping 2 inches and over.

2.05 ACCESSORIES
A. Stainless Steel Pipe: ASTM A269.
B. Pipe Alignment Guides:
   1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
C. Swivel Joints:
   1. Fabricated steel, Bronze, Ductile Iron or Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.

E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

F. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

G. Substitute grooved piping for vibration isolated equipment instead of flexible connectors. Grooved piping need not be anchored.

END OF SECTION
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SECTION 22 05 19
METERS AND GAGES FOR PLUMBING PIPING

PART 1  GENERAL
1.01  SECTION INCLUDES
   A. Positive displacement meters.
   B. Pressure gages and pressure gage taps.
   C. Thermometers and thermometer wells.
   D. Static pressure gages.
   E. Filter gages.

1.02  REFERENCE STANDARDS
   A. ASME B40.100 - Pressure Gauges and Gauge Attachments.
   E. AWWA C700 - Cold-Water Meters -- Displacement Type, Metal Alloy Main Case.
   F. AWWA C701 - Cold-Water Meters -- Turbine Type, for Customer Service.
   G. AWWA C702 - Cold-Water Meters -- Compound Type.
   H. AWWA C706 - Direct-Reading, Remote-Registration Systems for Cold Water Meters; American Water Works Association (ANSI/AWWA C706).
   J. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.03  SUBMITTALS
   A. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
   B. Project Record Documents: Record actual locations of components and instrumentation.
   C. Operation and Maintenance Data:

1.04  FIELD CONDITIONS
   A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

1.05  EXTRA MATERIALS
   A. Supply two bottles of red gage oil for static pressure gages.
   B. Supply two pressure gages with pulsation damper or dial thermometers.

PART 2  PRODUCTS
2.01  LIQUID FLOW METERS
   A. Manufacturers:
   B. Description: Totalizing turbine-type flow meter with rate indication and pulse output.
      1. Maximum Working Pressure:
a. PVC: 150 psi  
b. Carbon Steel: 200 psi  

2. Maximum Temperature:  
a. PVC: 49°C (120°F)  
b. Carbon Steel: 93°C (200°F)  

3. Accuracy: ±1% FS  

4. Signal: Squarewave pulse  

5. Power: 6 to 24 Vdc  

6. Materials  
a. Meter Body: PVC or carbon steel  
b. Flanges: Van Stone w/steel backing flange for PVC bodies, 150# ANSI for carbon steel bodies  
c. Turbine Rotor: PVDF  
d. Rotor Shafts: Zirconia ceramic  
e. Bearings: Sapphire journal, ruby ball  

7. Display  
a. Power: 11 to 24 Vdc, 20 mA max  
b. Rate: 8-digit autorange  
c. Total: 8-digit, selectable decimal  
d. Memory: Non-volatile (no battery needed)  
e. Pulse Output: 0.1 sec, open collector Analog Option 4 to 20 mA, user-programmable  

8. Transmitter  
a. Output: 4 to 20 mA  
b. Loop Power: 12 to 26 Vdc (isolated)  
c. Accuracy: ±1%  
d. Response Time: 3 sec, 95% FS  

2.02 PRESSURE GAGES  

A. Manufacturers:  

B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.  
1. Case: Steel with brass bourdon tube.  
2. Size: 4-1/2 inch diameter.  
3. Size: 2 inch diameter.  
4. Mid-Scale Accuracy: One percent.  
5. Scale: Psi.  

2.03 PRESSURE GAGE TAPPINGS  

A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.  
B. Needle Valve: Brass or Stainless Steel, 1/4 inch NPT for minimum 150 psi.  
C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.  
D. Syphon: Steel, Schedule 40, 1/4 inch angle or straight pattern.  

2.04 STEM TYPE THERMOMETERS  

A. Manufacturers:  
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Size: 9 inch scale.
   4. Window: Clear glass or Lexan.
   5. Accuracy: 2 percent, per ASTM E77.
   6. Calibration: Degrees F.

C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
   1. Size: 9 inch scale.
   2. Window: Clear Lexan.
   3. Size: 9 inch scale.
   4. Window: Clear glass or Lexan.
   5. Stem: 3/4 inch NPT brass.
   6. Accuracy: 2 percent, per ASTM E77.
   7. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS
A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 TEST PLUGS
A. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
B. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1 inch dial thermometers.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer’s instructions.
B. Install positive displacement meters with isolating valves on inlet and outlet to AWWA M6. Provide full line size valved bypass with globe valve for liquid service meters.
C. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
D. Install pressure gages with pulsation dampers. Provide gage cock or needle valve to isolate each gage. Extend nipples and siphons to allow clearance from insulation.
E. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
F. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 09 43.

G. Coil and conceal excess capillary on remote element instruments.

H. Provide instruments with scale ranges selected according to service with largest appropriate scale.

I. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.

J. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

K. Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, adjacent to control device sockets or where indicated.

3.02 SCHEDULES

A. Positive Displacement Meters, Location:
   1. Domestic cold water.
   2. Expansion tank make-up.

B. Pressure Gages, Location and Scale Range:
   1. Pumps, 0 to 100 psi.
   2. Expansion tanks, 0 to 100 psi.
   3. Sprinkler system, 0 to 100 psi.
   4. Backflow preventers, 0 to 100 psi.

C. Pressure Gage Tappings, Location:
   3. Heat exchangers - inlets and outlets.

D. Stem Type Thermometers, Location and Scale Range:
   1. Domestic hot water supply and recirculation, 0 to 220 degrees F.

END OF SECTION
SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

SEE SPECIFICATION SECTION 23 05 48

END OF SECTION
SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1  GENERAL

1.01 SECTION INCLUDES
A. Nameplates.
B. Tags.
C. Stencils.
D. Pipe Markers.

1.02 RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating: Identification painting.
B. Section 22 60 05 - Medical Air, Gas, and Vacuum Systems: Supply of pipe labels for placement under this section.

1.03 REFERENCE STANDARDS
A. ASME A13.1 - Scheme for the Identification of Piping Systems; The American Society of Mechanical Engineers.

1.04 SUBMITTALS
A. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
C. Product Data: Provide manufacturers catalog literature for each product required.
D. Samples: Submit two labels; tags in size.
E. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
F. Project Record Documents: Record actual locations of tagged valves.

PART 2  PRODUCTS

2.01 PLUMBING COMPONENT IDENTIFICATION GUIDELINE
A. Pipe Markers: 3/4 inch diameter and higher.

2.02 MANUFACTURERS
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 NAMEPLATES
A. Description: Laminated three-layer plastic with engraved letters.
   1. Letter Color: Black.
   2. Letter Height: 1/2 inch.

2.04 TAGS
A. Plastic Tags: Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inch diameter or square.
B. Metal Tags: Brass, aluminum, or stainless steel with stamped letters; tag size minimum 1-1/2 inch diameter or square with smooth edges.
2.05 STENCILS

A. Stencils: With clean cut symbols and letters of following size:
   1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
   2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
   3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
   4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
   5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.

B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors conforming to ASME A13.1.

2.06 PIPE MARKERS

A. Comply with ASME A13.1.

B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.

C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.

D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.07 CEILING TACKS

A. Description: Steel with 3/4 inch diameter color coded head.

B. Color code as follows:
   1. HVAC Equipment: Yellow.
   2. Fire Dampers and Smoke Dampers: Red.

PART 3 EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces to receive adhesive for identification materials.

B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.02 INSTALLATION

A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.

B. Install tags with corrosion resistant chain.

C. Apply stencil painting in accordance with Section 09 90 00.

D. Install plastic pipe markers in accordance with manufacturer's instructions.

E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.

G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates or stencil painting. Small devices, such as in-line pumps, may be identified with tags.

H. Identify control panels and major control components outside panels with plastic nameplates.

I. Identify thermostats relating to terminal boxes or valves with nameplates.

J. Identify valves in main and branch piping with tags.

K. Identify air terminal units and radiator valves with numbered tags.

L. Tag automatic controls, instruments, and relays. Key to control schematic.

M. Identify piping, concealed or exposed, with plastic pipe markers or plastic tape pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

N. Identify ductwork with plastic nameplates or stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.

O. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Flexible elastomeric cellular insulation.
   B. Piping insulation.
   C. Jackets and accessories.

1.02 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 22 10 05 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS
   A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   L. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.

1.04 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Samples: Submit two samples of any representative size illustrating each insulation type.
C. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum 3 years of experience, or and approved by manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS
A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS
2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER
A. Manufacturers:
B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F; 1200 degrees F; 1600 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
C. Insulation: ASTM C547; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 650 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
D. Vapor Barrier Jacket: White Kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
F. Vapor Barrier Lap Adhesive:
   1. Compatible with insulation.
G. Insulating Cement/Mastic:
1. ASTM C195; hydraulic setting on mineral wool.

H. Fibrous Glass Fabric:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5x5; 10x10; or 10x20.

I. Indoor Vapor Barrier Finish:
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, black or white color.

J. Outdoor Vapor Barrier Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

K. Outdoor Breather Mastic:
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

L. Insulating Cement:
   1. ASTM C449/C449M.

2.03 CELLULAR GLASS

A. Manufacturers:
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C552, Grade 1.
   1. 'K' value: 0.37 at 100 degrees F.
   2. Service Temperature: Up to 900 degrees F.
   3. Water Vapor Permeability: 0.005 perm inch.
   4. Water Absorption: 0.2 percent by volume, maximum.

2.04 EXPANDED POLYSTYRENE

A. Manufacturers:

B. Insulation: ASTM C578; rigid closed cell.
   1. 'K' value: 0.23 at 75 degrees F.
   2. Maximum service temperature: 165 degrees F.
   3. Maximum water vapor permeance: 5.0 perms

2.05 EXPANDED PERLITE

A. Manufacturers:

B. Insulation: ASTM C610, molded.
   1. Maximum service temperature: 1200 degrees F.
   2. Maximum water vapor transmission: 0.1 perm.

2.06 POLYISOCYANURATE CELLULAR PLASTIC

A. Insulation Material: ASTM C591, rigid molded modified polyisocyanurate cellular plastic.
   1. Dimension: Comply with requirements of ASTM C585.
   2. 'K' value: 0.18 at 75 degrees F, when tested in accordance with ASTM C518.
   3. Minimum Service Temperature: -70 degrees F.
   4. Maximum Service Temperature: 300 degrees F.
   5. Water Absorption: 0.5 percent by volume, maximum, when tested in accordance with ASTM D2842..
   6. Moisture Vapor Transmission: 4.0 perm in.
2.07 POLYETHYLENE
   A. Manufacturers:
   B. Insulation: Flexible closed-cell polyethylene tubing, slit lengthwise for installation, complying
      with applicable requirements of ASTM D1056.
      1. 'K' value: ASTM C177; 0.25 at 75 degrees F.
      2. Maximum Service Temperature: 200 degrees F.
      4. Maximum Moisture Absorption: 1.0 percent by volume.
      5. Moisture Vapor Permeability: 0.05 perm inch, when tested in accordance with ASTM
         E96/E96M.
      6. Connection: Contact adhesive.

2.08 FLEXIBLE ELASTOMERIC CELLULAR INSULATION
   A. Manufacturer:
      2. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C
      534 Grade 3; grade 2; grade 1 use molded tubular material wherever possible.
      1. Minimum Service Temperature: -40 degrees F.
      2. Maximum Service Temperature: 220 degrees F.
   C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.09 JACKETS
   A. PVC Plastic.
      1. Manufacturers:
         b. Substitutions: See Section 01 60 00 - Product Requirements.
      2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
         a. Minimum Service Temperature: 0 degrees F.
         b. Maximum Service Temperature: 150 degrees F.
         c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in
            accordance with ASTM E96/E96M.
         d. Thickness: 20 mil; 30 mil.
         e. Connections: Brush on welding adhesive, tacks, pressure sensitive color matching
            vinyl tape.
      3. Covering Adhesive Mastic:
   B. ABS Plastic:
      1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
         a. Minimum Service Temperature: -40 degrees F.
         b. Maximum Service Temperature of 180 degrees F.
         c. Moisture Vapor Permeability: 0.012 perm inch, when tested in accordance with
            ASTM E96/E96M.
         d. Thickness: 30 mil.
         e. Connections: Brush on welding adhesive.
   C. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant
      lagging adhesive.
      1. Lagging Adhesive:
a. Compatible with insulation.

   1. Thickness: 0.016 inch, 0.020 inch sheet.
   2. Finish: Smooth, embossed.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

E. Stainless Steel Jacket: ASTM A 666, Type 304 or 316 stainless steel.
   1. Thickness: 0.010 inch.
   2. Finish: Smooth.
   3. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
H. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
I. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.

L. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

M. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.

N. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULES
3.04 INTERIOR INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot, recirculated hot water.
1. Operating Temperature: 60 to 140 deg F.
2. Insulation Material: Flexible elastomeric or glass fiber.
3. Insulation Thickness: Apply the following insulation thicknesses:
   a. Pipe, All Sizes: 1.0 inch.
4. Jacket:
   a. Exposed Spaces (mechanical rooms, closets, etc.) = PVC
   b. Concealed Spaces = None
5. Vapor Retarder Required: No.
6. Finish: None.

B. Service: Domestic cold water.
1. Operating Temperature: 35 to 60 deg F.
2. Insulation Material: Flexible elastomeric or glass fiber.
3. Insulation Thickness: Apply the following insulation thicknesses:
   a. Pipe, 1" or less: 0.5 inch.
   b. Pipe, 1¼" to 2": 0.5 inch.
   c. Pipe, 2-1/2" to 4": 1.0 inch.
   d. Pipe, 5" and up: 1.0 inch.
4. Jacket:
   a. Exposed Spaces (mechanical rooms, closets, etc.) = PVC
   b. Concealed Spaces = None
5. Vapor Retarder Required: Yes.
6. Finish: None.

C. Service: Rainwater conductors.
1. Operating Temperature: 32 to 100 deg F.
2. Insulation Material: Mineral fiber.
3. Insulation Thickness: Apply the following insulation thicknesses:
   a. Pipe, 3" and up: 1.0 inch.
4. Jacket:
   a. Concealed Piping - None
   b. Exposed Piping - PVC
5. Vapor Retarder Required: Yes.
6. Finish: None.

D. Service: Roof drain bodies.
   1. Operating Temperature: 32 to 100 deg F.
   2. Insulation Material: Mineral fiber.
   3. Insulation Thickness: 1.0 inch.
   4. Jacket:
      a. Concealed - None
      b. Exposed - PVC
   5. Vapor Retarder Required: Yes.
   6. Finish: None.

E. Service: Sanitary waste piping where heat tracing is installed.
   1. Operating Temperature: 35 to 100 deg F.
   2. Insulation Material: Mineral fiber.
   3. Insulation Thickness: Apply the following insulation thicknesses:
      a. Pipe, 3" and up: 1.0 inch.
   5. Vapor Retarder Required: Yes.
   6. Finish: None.

F. Service: Condensate drain piping.
   1. Operating Temperature: 35 to 75 deg F.
   2. Insulation Material: Flexible elastomeric.
   3. Insulation Thickness: Apply the following insulation thicknesses:
      a. Pipe, 3" and up: 1.0 inch.
   4. Jacket: None.
   5. Vapor Retarder Required: Yes.
   6. Finish: None.

G. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.
   1. Operating Temperature: 35 to 120 deg F.
   2. Insulation Material: Molded closed cell vinyl.
   3. Insulation Thickness: 3/16 inch.
   4. Vapor Retarder Required: No.
   5. Finish: None.

3.05 EXTERIOR INSULATION APPLICATION SCHEDULE

A. This application schedule is for aboveground insulation outside the building. Loose-fill insulation, for belowground piping, is specified in Division 2 piping distribution Sections.

B. Service: Domestic water.
   1. Operating Temperature: 60 to 180 deg F.
   2. Insulation Material: Cellular glass, with jacket
   3. Insulation Thickness: Apply the following insulation thicknesses:
      a. Pipe, 1" or less: 2.0 inch.
      b. Pipe, 1-1/4" and larger: 2.0 inch.
   5. Vapor Retarder Required: No.
   6. Finish: None.

C. Service: Storm water.
   1. Operating Temperature: 32 to 100 deg F.
   2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: Apply the following insulation thicknesses:
   a. Pipe, 1-1/4" to 2": 0.5 inch.
   b. Pipe, 2-1/2" and up: 1.0 inch.
5. Vapor Retarder Required: Yes.
6. Finish: None.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, valves, and connections for piping systems.
   1. Sanitary sewer.
   2. Acid Waste (Chemical Resistant).
   3. Domestic water.
   4. Storm water.
   5. Gas.
   6. Flanges, unions, and couplings.
   7. Pipe hangers and supports.
   8. Ball valves.
   10. Flow controls.
   11. Check.
   12. Water pressure reducing valves.
   13. Relief valves.

1.02 RELATED REQUIREMENTS

A. Section 31 23 16 - Excavation.
B. Section 31 23 23 - Fill.
C. Section 31 23 16.13 - Trenching.
D. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems.
E. Section 07 84 00 - Firestopping.
F. Section 08 31 00 - Access Doors and Panels.
G. Section 09 90 00 - Painting and Coating.
H. Section 22 05 16 - Expansion Fittings and Loops for Plumbing Piping.
I. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
J. Section 22 07 19 - Plumbing Piping Insulation.
K. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.
L. Section 33 01 10.58 - Disinfection of Water Utility Piping Systems.

1.03 REFERENCE STANDARDS

C. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
D. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
E. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
F. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
G. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
H. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
I. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings—DWV.

J. ASME B31.1 - Power Piping.

K. ASME B31.2 - Fuel Gas Piping; The American Society of Mechanical Engineers.

L. ASME B31.9 - Building Services Piping.


N. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.


V. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed.

W. ASTM B68M - Standard Specification for Seamless Copper Tube, Bright Annealed (Metric).

X. ASTM B75/B75M - Standard Specification for Seamless Copper Tube.

Y. ASTM B75M - Standard Specification for Seamless Copper Tube (Metric).


AA. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric).


AF. ASTM C14 - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.

AG. ASTM C14M - Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe (Metric).


AP. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


BB. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.


BF. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.

BG. ASTM D2996 - Standard Specification for Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.

BH. ASTM D2997 - Standard Specification for Centrifugally Cast "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.
BJ. ASTM D3262 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.
BK. ASTM D3517 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe.
BL. ASTM D3754 - Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe.
BY. ASTM F1282 - Standard Specification for Polyethylene/Aluminum/Polyethylene (PE-AL-PE) Composite Pressure Pipe.
BZ. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
CA. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
CC. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
CD. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.
CE. AWWA C651 - Disinfecting Water Mains.
CF. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 mm Through 1,500 mm).
CG. AWWA C901 - Polyethylene (PE) Pressure Pipe and Tubing, 3/4 In. (19 mm) Through 3 In. (76 mm), for Water Service.
CH. AWWA C950 - Fiberglass Pressure Pipe.
CL. MSS SP-67 - Butterfly Valves.
CM. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
CN. MSS SP-70 - Gray Iron Gate Valves, Flanged and Threaded Ends.
CO. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends.
CP. MSS SP-78 - Gray Iron Plug Valves, Flanged and Threaded Ends.
CQ. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves.
CS. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.
CT. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.04 SUBMITTALS
A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
B. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE
A. Perform Work in accordance with local standards.
   1. Maintain one copy on project site.
B. Valves: Manufacturer's name and pressure rating marked on valve body.
C. Welding Materials and Procedures: Conform to ASME (BPV IX) and applicable state labor regulations.
D. Welder Qualifications: Certified in accordance with ASME (BPV IX).
E. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 REGULATORY REQUIREMENTS
A. Perform Work in accordance with local plumbing code.
B. Conform to applicable code for installation of backflow prevention devices.
C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
B. Provide temporary protective coating on cast iron and steel valves.
C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.08 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.

1.09 EXTRA MATERIALS
A. Provide two repacking kits for each size valve.

PART 2 PRODUCTS
2.01 SANITARY SEWER PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
B. PVC Pipe: ASTM D 3034 SDR 35. As permitted by code.
   1. Fittings: PVC.
C. PVC Pipe: ASTM D 2665 or ASTM D 3034. As permitted by code.
   1. Fittings: PVC.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
B. Cast Iron Pipe: CISPI 301, hubless.
   1. Fittings: Cast iron.
   2. Joints: CISPI 310, neoprene gasket and stainless steel clamp and shield assemblies.

2.03 SANITARY SEWER PIPING, ABOVE GRADE
A. Cast Iron Pipe: ASTM A74, service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
C. PVC Pipe: ASTM D1785 Schedule 40, or ASTM D2241 SDR 26 for not less than 150 psi pressure rating.
   1. Fittings: ASTM D2466, PVC.

2.04 WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING
   1. Fittings: AWWA C110, ductile or gray iron, standard thickness.
B. Copper Pipe: ASTM B42, hard drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
2.05 WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Copper Pipe: ASTM B42, hard drawn.
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2.06 WATER PIPING, ABOVE GRADE
A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
   1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

2.07 STORM WATER PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
   1. Fittings: Concrete, as specified for pipe.
C. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.

2.08 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.

2.09 STORM WATER PIPING, ABOVE GRADE
A. Cast Iron Pipe: ASTM A74 service weight.
   1. Fittings: Cast iron.
   2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
B. Cast Iron Pipe: CISPI 301, hubless, service weight.
   1. Fittings: Cast iron.
C. PVC Pipe: ASTM D2665 or ASTM D3034.
   1. Fittings: PVC.

2.10 NATURAL GAS PIPING, BURIED BEYOND 5 FEET OF BUILDING
A. Polyethylene Pipe: ASTM D2513, SDR 11.
   1. Fittings: ASTM D2683 or ASTM D2513 socket type.

2.11 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING
A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   2. Joints: ASME B31.1 or ASME B31.9, welded.
   3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.
2.12 NATURAL GAS PIPING, ABOVE GRADE
A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
   2. Joints: NFPA 54, threaded or welded to ASME B31.1 or ASME B31.9.

2.13 FLANGES, UNIONS, AND COUPLINGS
A. Unions for Pipe Sizes 3 Inches and Under:
   1. Ferrous pipe: Class 150 malleable iron threaded unions.
   2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
B. Flanges for Pipe Size Over 1 Inch:
   1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
   2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
C. Grooved and Shouldered Pipe End Couplings:
   1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
   2. Sealing gasket: "C" shape composition sealing gasket.
D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

2.14 PIPE HANGERS AND SUPPORTS
A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
   2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
   3. Trapeze Hangers: Welded steel channel frames attached to structure.
B. Plumbing Piping - Drain, Waste, and Vent:
   2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
   4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
   5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
   8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
C. Plumbing Piping - Water:
   2. Hangers for Pipe Sizes 1/2 Inch to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
   3. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron pipe roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded supports or spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded supports or spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
10. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron pipe roll.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 Inches: Cast iron adjustable pipe saddle, locknut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron pipe roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.15 GATE VALVES
A. Manufacturers:
B. Up To and Including 3 Inches:
   1. 1, Class 125, bronze body, bronze trim, rising stem, handwheel, inside screw, solid wedge disc, solder ends.
C. 2 Inches and Larger:
   1. 1, Class 125, iron body, bronze trim, outside screw and yoke, handwheel, solid wedge disc, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.16 GLOBE VALVES
A. Manufacturers:
B. Up To and Including 3 Inches:
   1. 1, Class 125, bronze body, bronze trim, handwheel, bronze disc, solder ends.
C. 2 Inches and Larger:
   1. 1, Class 125, iron body, bronze trim, handwheel, outside screw and yoke, renewable bronze plug-type disc, renewable seat, flanged ends. Provide chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.17 BALL VALVES
A. Manufacturers:
B. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze or ductile iron body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

C. Construction, 4 Inches and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze, two piece body, chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, solder ends with union.

2.18 PLUG VALVES
A. Manufacturers:
B. Construction 2-1/2 Inches and Larger: 1, 175 psi CWP, cast iron body and plug, pressure lubricated, teflon or Buna N packing, flanged or grooved ends. Provide lever operator with set screw.

2.19 BUTTERFLY VALVES
A. Manufacturers:
B. Construction 1-1/2 Inches and Larger: MSS SP-67, 200 psi CWP, cast or ductile iron body, nickel-plated ductile iron disc, resilient replaceable EPDM, Buna N, or EPT seat, wafer, lug, or grooved ends, extended neck, 10 position lever handle.
C. Provide gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

2.20 FLOW CONTROLS
A. Manufacturers:
B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi psi.

2.21 SWING CHECK VALVES
A. Manufacturers:
B. Up to 3 Inches:
   1. 1, Class 125, bronze body and cap, bronze swing disc with rubber seat, solder ends.
C. Over 3 Inches:
   1. 1, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.
2.22 SPRING LOADED CHECK VALVES
A. Manufacturers:
B. Class 125, iron body, bronze trim, stainless steel springs, bronze disc, Buna N seals, wafer style ends.

2.23 WATER PRESSURE REDUCING VALVES
A. Manufacturers:
B. Up to 2 Inches:
1. MSS SP-80, bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single or double union ends.
C. Over 2 Inches:
1. MSS SP-85, cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

2.24 RELIEF VALVES
2.25 STRAINERS
2.26 RELIEF VALVES
A. Pressure Relief:
1. Manufacturers:
2. AGA Z21.22 certified, bronze body, teflon seat, steel stem and springs, automatic, direct pressure actuated.
B. Temperature and Pressure Relief:
1. Manufacturers:
2. AGA Z21.22 certified, bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, temperature relief maximum 210 degrees F, capacity ASME (BPV IV) certified and labelled.

2.27 STRAINERS
A. Manufacturers:
B. Size 2 inch and Under:
1. Threaded brass body for 175 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
2. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32 inch stainless steel perforated screen.
C. Size 1-1/2 inch to 4 inch:
1. Class 125, flanged iron body, Y pattern with 1/16 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
   1. Class 125, flanged iron body, basket pattern with 1/8 inch stainless steel perforated screen.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION
   A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
   B. Remove scale and dirt, on inside and outside, before assembly.
   C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION
   A. All gas piping shall be painted standard ANSI yellow.
   B. Install in accordance with manufacturer's instructions.
   C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
   D. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
   E. Install piping to maintain headroom, conserve space, and not interfere with use of space.
   F. Group piping whenever practical at common elevations.
   G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
   H. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.
   I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.
   J. Establish elevations of buried piping outside the building to ensure not less than 3 ft of cover.
   K. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
   L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
   M. Provide support for utility meters in accordance with requirements of utility companies.
   N. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.
   O. Excavate in accordance with Section 31 23 16.
   P. Backfill in accordance with Section 31 23 23.
   Q. Install bell and spigot pipe with bell end upstream.
   R. Install valves with stems upright or horizontal, not inverted.
   S. Pipe vents from gas pressure reducing valves to outdoors and terminate in weather proof hood.
   T. Install water piping to ASME B31.9.
   U. Install fuel oil piping to ASME B31.9.
   V. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
   W. Sleeve pipes passing through partitions, walls and floors.
X. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.

Y. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
   7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   8. Provide copper plated hangers and supports for copper piping.
   9. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
  10. Provide hangers adjacent to motor driven equipment with vibration isolation; refer to Section 22 05 48.
  11. Support cast iron drainage piping at every joint.

3.04 APPLICATION
   A. Use grooved mechanical couplings and fasteners only in accessible locations.
   B. Install unions downstream of valves and at equipment or apparatus connections.
   C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
   D. Install gate or ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
   E. Install globe valves for throttling, bypass, or manual flow control services.
   F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
   G. Provide spring loaded check valves on discharge of water pumps.
   H. Provide plug valves in natural gas systems for shut-off service.
   I. Provide flow controls in water recirculating systems where indicated.

3.05 TOLERANCES
   A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/4 inch per foot slope.
   B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
   A. Disinfect water distribution system in accordance with Section 33 01 10.58.
B. Prior to starting work, verify system is complete, flushed and clean.

C. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

D. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

F. Maintain disinfectant in system for 24 hours.

G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer services. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Provide new water service complete with approved reduced pressure backflow preventer and water meter with by-pass valves, pressure reducing valve.
   1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Calk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
   2. Provide 18 gage galvanized sheet metal sleeve around service main to 6 inch above floor and 6 feet minimum below grade. Size for minimum of 2 inches of loose batt insulation stuffing.

C. Provide new gas service complete with gas meter and regulators. Gas service distribution piping to have initial minimum pressure of 7 inch wg. Provide regulators on each line serving gravity type appliances, sized in accordance with equipment.

3.08 SCHEDULES

A. Pipe Hanger Spacing:
   1. Metal Piping:
      a. Pipe size: 1/2 inches to 1-1/4 inches:
         1) Maximum hanger spacing: 6.5 ft.
         2) Hanger rod diameter: 3/8 inches.
      b. Pipe size: 1-1/2 inches to 2 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 3/8 inch.
      c. Pipe size: 2-1/2 inches to 3 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 1/2 inch.
      d. Pipe size: 4 inches to 6 inches:
         1) Maximum hanger spacing: 10 ft.
         2) Hanger rod diameter: 5/8 inch.
      e. Pipe size: 8 inches to 12 inches:
         1) Maximum hanger spacing: 14 ft.
         2) Hanger rod diameter: 7/8 inch.
      f. Pipe size: 14 inches and Over:
         1) Maximum hanger spacing: 20 ft.
2) Hanger rod diameter: 1 inch.

2. Plastic Piping:
   a. Pipe Size 1" to 6":
      1) Maximum hanger spacing: 6 ft.
      2) Hanger rod diameter: 3/8 inch.
   b. Pipe Size 8" and Over:
      1) Maximum hanger spacing: 6 ft.
      2) Hanger rod diameter: 7/8 inch.

END OF SECTION
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SECTION 22 10 06
PLUMBING PIPING SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Roof and floor drains.
B. Cleanouts.
C. Hydrants.
D. Backflow preventers.
E. Water hammer arrestors.
F. Interceptors.
G. Thermostatic mixing valves.
H. Catch basins and manholes.

1.02 RELATED REQUIREMENTS
A. Section 33 05 61 - Concrete Manholes.
B. Section 03 30 00 - Cast-in-Place Concrete: Manhole bottoms.
C. Section 22 10 05 - Plumbing Piping.
D. Section 22 40 00 - Plumbing Fixtures.
E. Section 22 30 00 - Plumbing Equipment.
F. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
A. ASME A112.6.3 - Floor and Trench Drains.
B. ASME A112.6.4 - Roof, Deck, and Balcony Drains.
C. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers.
D. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent.
E. ASSE 1013 - Performance Requirements for Reduced Pressure Principle Backflow Prevention Assemblies.
F. ASSE 1019 - Performance Requirements for Wall Hydrant with Backflow Protection and Freeze Resistance.
I. PDI-WH 201 - Water Hammer Arresters.

1.04 SUBMITTALS
A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
C. Certificates: Certify that grease or oil interceptors meet or exceed specified requirements.
D. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.
E. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, water hammer arrestors.
F. Operation Data: Indicate frequency of treatment required for interceptors.
G. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept specialties on site in original factory packaging. Inspect for damage.

1.07 EXTRA MATERIALS
A. Supply for Owner's use in maintenance of project:
   1. Two loose keys for outside hose bibbs.
   2. Two hose end vacuum breakers for hose bibbs.

PART 2 PRODUCTS
2.01 DRAINS
A. Manufacturers:
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Roof Drains:
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   3. Strainer: Removable polyethylene, cast metal, cast bronze, or cast iron dome with vandal proof screws.
   4. Accessories: Coordinate with roofing type.
      a. Membrane flange and membrane clamp with integral gravel stop.
      b. Adjustable under deck clamp.
      c. Roof sump receiver.
      d. Waterproofing flange.
      e. Controlled flow weir.
      f. Leveling frame.
      g. Adjustable extension sleeve for roof insulation.
      h. Perforated or slotted ballast guard extension for inverted roof.
      i. Perforated stainless steel ballast guard extension.
C. Parapet Drains:
   1. Lacquered or Galvanized cast iron body with aluminum flashing clamp collar and epoxy coated or nickel bronze sloping grate.
D. Canopy and Cornice Drains:
   1. Lacquered or Galvanized cast iron body with aluminum flashing clamp collar and epoxy coated or nickel bronze flat strainer.
E. Roof Overflow Drains:
   1. Lacquered or Galvanized cast iron body and clamp collar and bottom clamp ring; pipe extended to above flood elevation.
F. Downspout Nozzles:
   1. Bronze round with straight bottom section.

G. Area Drains:
   1. Assembly: ASME A112.6.4.
   2. Body: Lacquered cast iron with sump.
   4. Accessories: Membrane flange and membrane clamp with integral gravel stop, with adjustable under deck clamp, roof sump receiver, waterproofing flange, levelling frame, adjustable extension sleeve (for insulation), and perforated stainless steel ballast guard extension.

H. Floor Drains:
   1. Manufacturers:
      b. MIFAB, Inc; _____: www.mifab.com/#sle.

I. Floor Drain:
   1. ASME A112.6.3; lacquered cast iron two piece body with double drainage flange, weep holes, reversible clamping collar, and round, adjustable nickel-bronze strainer.

2.02 CLEANOUTS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Cleanouts at Exterior Surfaced Areas:
   1. Round cast nickel bronze access frame and non-skid cover.

C. Cleanouts at Exterior Unsurfaced Areas:
   1. Line type with lacquered cast iron body and round epoxy coated gasketed cover.

D. Cleanouts at Interior Finished Floor Areas:
   1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

E. Cleanouts at Interior Finished Wall Areas:
   1. Line type with lacquered cast iron body and round epoxy coated gasketed cover, and round stainless steel access cover secured with machine screw.

F. Cleanouts at Interior Unfinished Accessible Areas: Calked or threaded type. Provide bolted stack cleanouts on vertical rainwater leaders.

2.03 HYDRANTS

A. Manufacturers:

B. Wall Hydrants: Exterior
   1. ASSE 1019; tamper-proof, freeze resistant, self-draining type with chrome plated wall plate hose thread spout, handwheel, and integral vacuum breaker.

C. Roof Hydrant:
1. Freezeless, cast iron support components. Drain connection, EPDM Boot.

2.04 WATER HAMMER ARRESTORS

A. Manufacturers:
   4. Sioux Chief Company.
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Water Hammer Arrestors:
   1. Stainless steel construction, bellows or piston type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psi working pressure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer’s instructions.
B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
C. Encase exterior cleanouts in concrete flush with grade.
D. Install floor cleanouts at elevation to accommodate finished floor.
E. Install approved portable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.
F. Pipe relief from backflow preventer to nearest drain.
G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatories, sinks, washing machines, toilets, urinal and any other quick closing valves.

END OF SECTION
SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Water closets.
   B. Lavatories.
   C. Sinks.
   D. Service sinks.
   E. Sinks.

1.02 RELATED REQUIREMENTS
   A. Section 07 90 05 - Joint Sealers: Seal fixtures to walls and floors.
   B. Section 22 10 05 - Plumbing Piping.
   C. Section 22 10 06 - Plumbing Piping Specialties.
   D. Section 22 30 00 - Plumbing Equipment.
   E. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS
   C. IAPMO Z124 - Plastic Plumbing Fixtures.
   F. ARI 1010 - Self-Contained, Mechanically-Refrigerated Drinking-Water Coolers; Air-Conditioning and Refrigeration Institute.
   G. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
   H. ASME A112.18.1 - Plumbing Supply Fittings.
   I. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures; The American Society of Mechanical Engineers.
   J. ASME A112.19.2 - Ceramic Plumbing Fixtures.
   K. ASME A112.19.3 - Stainless Steel Plumbing Fixtures.
   L. ASME A112.19.4M - Porcelain Enameled Formed Steel Plumbing Fixtures.
   M. ASME A112.19.5 - Flush Valves and Spuds for Water Closets, Urinals, and Tanks.

1.04 SUBMITTALS
   A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
   B. Samples: Submit two sets of color chips for each standard color.
   C. Manufacturer’s Instructions: Indicate installation methods and procedures.
   D. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
E. Waterless Urinals: Submit recommended frequency of maintenance and parts replacement, methods of cleaning, sources of replacement supplies and parts.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of experience.

1.06 REGULATORY REQUIREMENTS
   A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.07 MOCK-UP
   A. Provide mock-up of typical bathroom group.
   B. Mock-up may remain as part of the Work.

1.08 DELIVERY, STORAGE, AND HANDLING
   A. Accept fixtures on site in factory packaging. Inspect for damage.
   B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.09 WARRANTY
   A. Provide five year manufacturer warranty for electric water cooler.

1.10 EXTRA MATERIALS
   A. Supply two sets of faucet washers, flush valve service kits, and lavatory supply fittings.

PART 2 PRODUCTS

2.01 FLUSH VALVE WATER CLOSETS
      1. Flush Volume: 1.28 gallon, maximum.
      2. Flush Valve: Exposed (top spud).
      4. Handle Height: 44 inches or less.
      5. ASME A112.19.2; wall hung, siphon jet or wall hung blow out vitreous china closet bowl, with elongated rim, 1-1/2 inch top spud, china bolt caps.
      7. Manufacturers:
         b. Kohler.
         e. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Flush Valves: ASME A112.18.1, diaphragm type, complete with vacuum breaker stops and accessories.
      1. Manual Operated:
         a. Type: ASME A112.18.1 or ASME A112.19.5; diaphragm type complete with vacuum breaker stops, and accessories.
      2. Exposed Type: Chrome plated, escutcheon, integral screwdriver stop.
3. Metering Type: Easily accessible adjustment nut.
4. Manufacturers:
   a. Toto USA: www.totousa.com
   d. Substitutions: See Section 01 60 00 - Product Requirements.

C. Seats:
1. Manufacturers:
   a. Kohler
   d. DXV by American Standard, Inc; _____: www.dxv.com/#sle.
   f. Substitutions: See Section 01 60 00 - Product Requirements.
2. Solid black plastic, open front, extended back, self-sustaining hinge, brass bolts, with cover.

D. Water Closet Carriers:
1. Manufacturers:
   a. JR Smith.
   d. Substitutions: See Section 01 60 00 - Product Requirements.
2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.02 LAVATORIES
A. Lavatory Manufacturers:
1. American Standard Inc
2. Eljer
5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Cast Iron Wall Hung Basin: ASME A112.19.1; porcelain enamelled cast iron wall-hung lavatory, with 4 inch high back, drillings on 4 inch centers, rectangular
C. Supply Faucet Manufacturers:
D. Supply Faucet: ASME A112.18.1; chrome plated combination supply fitting with pop-up waste, water economy aerator with adjustable flow initially set to 0.5 gallon per minute (low-flow), single lever handle.
E. Accessories:
1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
2. Offset waste with perforated open strainer.
3. Screwdriver stops.
4. Rigid supplies.
5. Carrier:
   a. Manufacturers:
1) JR Smith
3) Zurn Industries, Inc: www.zurn.com/#sle.

b. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded studs for fixture hanger, or concealed arm supports bearing plate and studs.

2.03 SINKS
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Single Compartment Bowl
   1. ASME A112.19.3; 20 gauge, 0.0359 inch thick, Type 302 stainless steel, self rimming and undercoated, with ledge back drilled for trim.
C. Supply Faucet Manufacturers:
D. Supply Faucet: Gooseneck supply faucet with pop-up waste, water economy aerator with adjustable flow initially set to maximum flow of 1.5 gallon per minute, single lever handle.

2.04 WATER FOUNTAINS
A. Electric Water Cooler Manufacturers:
B. Fountain:
   1. A surface handicapped-height, fully ADA compliant mounted water fountain with stainless steel top, stainless steel; stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, bottle filling station, and mounting bracket. 
   2. Capacity: 8 gallons per hour of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F, when tested in accordance with ASHRAE Std 18.
   3. Electrical: 115 V, 60 Hertz compressor, 6 foot cord and plug for connection to electric wiring system including grounding connector or hard-wired connection. Coordinate with electrical contractor.
      a. Electrical: 6 foot cord and plug for connection to electric wiring system including grounding connector.

2.05 SERVICE SINKS
A. Service Sink Manufacturers:
   1. Mustee
   2. Kohler
B. Bowl:
1. White floor mounted, with one inch wide shoulders. Vinyl bumper guard stainless steel strainer.

C. Trim:
   1. ASME A112.18.1 exposed wall type supply with cross handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.

D. Accessories:
   1. Hose clamp hanger.
   2. Mop hanger.
   3. See plumbing schedules.

PART 3 EXECUTION

3.01 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.
   C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION
   A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION
   A. Install each fixture with trap, easily removable for servicing and cleaning.
   B. Provide chrome plated rigid or flexible supplies to fixtures with screwdriver stops, reducers, and escutcheons.
   C. Install components level and plumb.
   D. Install and secure fixtures in place with wall supports or wall carriers and bolts.
   E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 05, color to match fixture.
   F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS
   A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING
   A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING
   A. Clean plumbing fixtures and equipment.

END OF SECTION
SECTION 23 05 13
MOTOR REQUIREMENTS FOR HVAC AND PLUMBING EQUIP

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Single phase electric motors.
B. Three phase electric motors.

1.02 RELATED REQUIREMENTS
A. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.
B. Section 26 29 13 - Enclosed Controllers.

1.03 REFERENCE STANDARDS
A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
C. NEMA MG 1 - Motors and Generators.
D. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS
A. Product Data: Provide wiring diagrams with electrical characteristics and connection requirements.
B. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than 1/2 horsepower.
C. Manufacturer's Installation Instructions: Indicate setting, mechanical connections, lubrication, and wiring instructions.
D. Operation Data: Include instructions for safe operating procedures.
E. Maintenance Data: Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacture of electric motors for HVAC use, and their accessories, with minimum three years documented product development, testing, and manufacturing experience.
B. Conform to applicable electrical code, NFPA 70 and local energy code.
C. Provide certificate of compliance from authority having jurisdiction indicating approval of high efficiency motors.
D. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc. or testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

1.07 WARRANTY
A. Provide five year manufacturer warranty for motors larger than 20 horsepower.
PART 2 PRODUCTS

2.01 MANUFACTURERS
   B. Lincoln Motors:  www.lincolnmotors.com/#sle.

2.02 GENERAL CONSTRUCTION AND REQUIREMENTS
   A. Electrical Service:  Refer to Section 26 27 17 for required electrical characteristics.
   B. Electrical Service, General.  See drawings for specific details:
      1. Motors 1/2 HP and Smaller:  115 volts, single phase, 60 Hz.
      2. Motors Larger than 1/2 Horsepower:  460 volts, three phase, 60 Hz.
   C. Construction:
      1. Open drip-proof type except where specifically noted otherwise.
      2. Design for continuous operation in 40 degrees C environment.
      3. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class,
         service factor, and motor enclosure type.
      4. Motors with frame sizes 254T and larger:  Premium Efficiency Type.
   D. Explosion-Proof Motors:  UL approved and labelled for hazard classification, with over
      temperature protection.
   E. 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.
   F. Wiring Terminations:
      1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials
         indicated.  Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
      2. For fractional horsepower motors where connection is made directly, provide conduit
         connection in end frame.

2.03 APPLICATIONS
   A. Exception:  Motors less than 250 watts, for intermittent service may be the equipment
      manufacturer's standard and need not conform to these specifications.
   B. Single phase motors for shaft mounted fans and centrifugal pumps:  Split phase type.
   C. Single phase motors for shaft mounted fans or blowers:  Permanent split capacitor type or
      electronically commutated (ECM) type.  See schedules for requirements.
   D. Single phase motors for fans, pumps, and blowers:  Capacitor start type.
   E. Single phase motors for fans, blowers, and pumps:  Capacitor start, capacitor run type.
   F. Motors located in outdoors and in draw through cooling towers:  Totally enclosed weatherproof
      epoxy-treated type.

2.04 SINGLE PHASE POWER - SPLIT PHASE MOTORS
   A. Starting Torque:  Less than 150 percent of full load torque.
   B. Starting Current:  Up to seven times full load current.
   C. Breakdown Torque:  Approximately 200 percent of full load torque.
D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.

E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.05 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

A. Starting Torque: Exceeding one fourth of full load torque.

B. Starting Current: Up to six times full load current.

C. Multiple Speed: Through tapped windings.

D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

2.06 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve bearings.

G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

2.07 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between 1 and 1-1/2 times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.


E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with IEEE 112. Load test motors to determine free from electrical or mechanical defects in compliance with performance data.

G. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter; refer to Section 26 29 13.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA STD 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To NEMA MG 1.
K. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.

L. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.

M. Nominal Efficiency: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

N. Nominal Power Factor: As scheduled at full load and rated voltage when tested in accordance with IEEE 112.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.

C. Check line voltage and phase and ensure agreement with nameplate.

D. Provide detailed installation and purchase information for reimbursement by Utility for rebate program.

3.02 SCHEDULE - PREMIUM EFFICIENCY

A. NEMA Open Motor Service Factors.
   1. 1/6-1/3 hp:
      a. 3600 rpm: 1.35.
      b. 1800 rpm: 1.35.
      c. 1200 rpm: 1.35.
      d. 900 rpm: 1.35.
   2. 1/2 hp:
      a. 3600 rpm: 1.25.
      b. 1800 rpm: 1.25.
      c. 1200 rpm: 1.25.
      d. 900 rpm: 1.15.
   3. 3/4 hp:
      a. 3600 rpm: 1.25.
      b. 1800 rpm: 1.25.
      c. 1200 rpm: 1.15.
      d. 900 rpm: 1.15.
   4. 1 hp:
      a. 3600 rpm: 1.25.
      b. 1800 rpm: 1.15.
      c. 1200 rpm: 1.15.
      d. 900 rpm: 1.15.
   5. 1.5-150 hp:
      a. 3600 rpm: 1.15.
      b. 1800 rpm: 1.15.
      c. 1200 rpm: 1.15.
      d. 900 rpm: 1.15.

B. Three Phase - Premium Efficiency, Open Drip-Proof Performance:
   1. Ratings.
      a. 1 hp:
1) NEMA Frame: 145T.
2) Minimum Percent Power Factor: 72.
3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% @ 1800 RPM, 77% @ 3600 RPM

b. 1-1/2 hp:
1) NEMA Frame: 182T.
2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 86.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM

c. 2 hp:
1) NEMA Frame: 184T.
2) Minimum Percent Power Factor: 75.
3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM

d. 3 hp:
1) NEMA Frame: 213T.
2) Minimum Percent Power Factor: 60.
3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 89.5% @ 1800 RPM, 85.5% @ 3600 RPM

e. 5 hp:
1) NEMA Frame: 215T.
3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM

f. 7-1/2 hp:
1) NEMA Frame: 254T.
2) Minimum Percent Power Factor: 73.
3) Minimum Percent Efficiency: 90.2% @ 1200 RPM, 91% @ 1800 RPM, 88.5% @ 3600 RPM

g. 10 hp:
1) NEMA Frame: 256T.
2) Minimum Percent Power Factor: 74.
3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM

h. 15 hp:
1) NEMA Frame: 284T.
2) Minimum Percent Power Factor: 77.
3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 90.2% @ 3600 RPM

i. 20 hp:
1) NEMA Frame: 286T.
2) Minimum Percent Power Factor: 78.
3) Minimum Percent Efficiency: 92.4% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM

j. 25 hp:
1) NEMA Frame: 324T.
2) Minimum Percent Power Factor: 74.
3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM

k. 30 hp:
1) NEMA Frame: 326T.
2) Minimum Percent Power Factor: 78.
3) Minimum Percent Efficiency: 93.6% @ 1200 RPM, 94.1% @ 1800 RPM, 91.7% @ 3600 RPM

l. 40 hp:
   1) NEMA Frame: 364T.
   2) Minimum Percent Power Factor: 77.
   3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1 @ 1800 RPM, 92.4% @ 3600 RPM

m. 50 hp:
   1) NEMA Frame: 365T.
   2) Minimum Percent Power Factor: 79.
   3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM

C. Three Phase - Premium Efficiency, Totally Enclosed, Fan Cooled Performance:
   1. 1200 rpm.
   a. 1 hp:
      1) NEMA Frame: 145T.
      2) Minimum Percent Power Factor: 72.
      3) Minimum Percent Efficiency: 82.5% @ 1200 RPM, 85.5% @ 1800 RPM, 77% @ 3600 RPM
   b. 1-1/2 hp:
      1) NEMA Frame: 182T.
      2) Minimum Percent Power Factor: 73.
      3) Minimum Percent Efficiency: 87.5% @ 1200 RPM, 86.5% @ 1800 RPM, 84% @ 3600 RPM
   c. 2 hp:
      1) NEMA Frame: 184T.
      2) Minimum Percent Power Factor: 68.
      3) Minimum Percent Efficiency: 88.5% @ 1200 RPM, 86.5% @ 1800 RPM, 85.5% @ 3600 RPM
   d. 3 hp:
      1) NEMA Frame: 213T.
      2) Minimum Percent Power Factor: 63.
      3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 86.5% @ 3600 RPM
   e. 5 hp:
      1) NEMA Frame: 215T.
      3) Minimum Percent Efficiency: 89.5% @ 1200 RPM, 89.5% @ 1800 RPM, 88.5% @ 3600 RPM
   f. 7-1/2 hp:
      1) NEMA Frame: 254T.
      2) Minimum Percent Power Factor: 68.
      3) Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 89.5% @ 3600 RPM
   g. 10 hp:
      1) NEMA Frame: 256T.
      2) Minimum Percent Power Factor: 75.
      3) Minimum Percent Efficiency: 91% @ 1200 RPM, 91.7% @ 1800 RPM, 90.2% @ 3600 RPM
h. 15 hp:
   1) NEMA Frame: 284T.
   2) Minimum Percent Power Factor: 72.
   3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 92.4% @ 1800 RPM, 91% @ 3600 RPM

i. 20 hp:
   1) NEMA Frame: 286T.
   2) Minimum Percent Power Factor: 76.
   3) Minimum Percent Efficiency: 91.7% @ 1200 RPM, 93% @ 1800 RPM, 91% @ 3600 RPM

j. 25 hp:
   1) NEMA Frame: 324T.
   3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM

k. 30 hp:
   1) NEMA Frame: 326T.
   2) Minimum Percent Power Factor: 79.
   3) Minimum Percent Efficiency: 93% @ 1200 RPM, 93.6% @ 1800 RPM, 91.7% @ 3600 RPM

l. 40 hp:
   1) NEMA Frame: 364T.
   2) Minimum Percent Power Factor: 78.
   3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.1% @ 1800 RPM, 92.4% @ 3600 RPM

m. 50 hp:
   1) NEMA Frame: 365T.
   2) Minimum Percent Power Factor: 81.
   3) Minimum Percent Efficiency: 94.1% @ 1200 RPM, 94.5% @ 1800 RPM, 93% @ 3600 RPM

END OF SECTION
SECTION 23 05 16
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Flexible pipe connectors.
B. Expansion joints and compensators.
C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS
A. Section 23 21 13 - Hydronic Piping.

1.03 REFERENCE STANDARDS
B. EJMA (STDS) - EJMA Standards.

1.04 SUBMITTALS
A. Product Data:
   1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
   2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
B. Design Data: Indicate selection calculations.
C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.
D. Project Record Documents: Record installed locations of flexible pipe connectors, expansion joints, anchors, and guides.
E. Maintenance Data: Include adjustment instructions.

1.05 REGULATORY REQUIREMENTS
A. Conform to UL requirements.

1.06 EXTRA MATERIALS
A. Supply two sets of packing for each packed expansion joint.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING
A. Manufacturers:
B. Inner Hose: Carbon Steel.
C. Exterior Sleeve: Single braided, stainless steel or bronze.
D. Pressure Rating: 125 psi and 450 degrees F.
E. Joint: As specified for pipe joints.
F. Size: Use pipe sized units.
G. Maximum offset: 3/4 inch on each side of installed center line.
2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING
   A. Manufacturer:
   B. Inner Hose: Bronze.
   C. Exterior Sleeve: Braided bronze.
   D. Pressure Rating: 125 psi and 450 degrees F.
   E. Joint: As specified for pipe joints.
   F. Size: Use pipe sized units.
   G. Maximum offset: 3/4 inch on each side of installed center line.
   H. Application: Copper piping.

2.03 EXPANSION JOINTS - STAINLESS STEEL BELLOWS TYPE
   A. Manufacturers:
   B. Pressure Rating: 125 psi and 400 degrees F.
   D. Maximum Extension: 1/4 inch.
   E. Joint: As specified for pipe joints.
   F. Size: Use pipe sized units.
   G. Application: Steel piping 3 inches and under.

2.04 EXPANSION JOINTS - EXTERNAL RING CONTROLLED STAINLESS STEEL BELLOWS TYPE
   A. Manufacturers:
   B. Pressure Rating: 125 psi and 400 degrees F.
   C. Maximum Compression: 15/16 inch.
   D. Maximum Extension: 5/16 inch.
   E. Maximum Offset: 1/8 inch.
   F. Joint: Flanged.
   G. Size: Use pipe sized units.
   H. Accessories: Internal flow liner.
   I. Application: Steel piping over 2 inches.

2.05 EXPANSION JOINTS - SINGLE SPHERE, ELBOW OR FLEXIBLE COMPENSATOR
   A. Manufacturers:
   B. Body: Teflon.
   C. Pressure Rating, Sizes 3/4 Inch to 2 Inch: 150 psi and 210 degrees F.
   D. Pressure Rating, Sizes 1-1/2 Inch to 12 Inch: 150 psi and 250 degrees F.
   E. Pressure Rating, Sizes 14 Inch to 24 Inch: 105 psi and 250 degrees F.
F. Maximum Compression: 3/4 inch.

G. Maximum Elongation: 1/2 inch.

H. Maximum Offset: 1/2 inch.

I. Maximum Angular Movement: 15 degrees.

J. Joint: Tapped steel flanges.

K. Size: Use pipe sized units.

L. Accessories: Control rods.

M. Application: Steel piping 2 inches and over.

2.06 EXPANSION JOINTS - TWO-PLY BRONZE BELLOWS TYPE

A. Manufacturers:

B. Construction: Bronze with anti-torque device, limit stops, internal guides.

C. Pressure Rating: 125 psi and 400 degrees F.


E. Maximum Extension: 1/4 inch.

F. Joint: As specified for pipe joints.

G. Size: Use pipe sized units.

H. Application: Copper piping.

2.07 EXPANSION JOINTS - LOW PRESSURE COMPENSATOR WITH TWO-PLY BRONZE BELLOWS

A. Manufacturers:

B. Working Pressure: 75 psi.

C. Maximum Temperatures: 250 degrees F.

D. Maximum Compression: 1/2 inch.

E. Maximum Extension: 5/32 inch.

F. Joint: Soldered.

G. Size: Use pipe sized units.

H. Application: Copper or steel piping 3 inches and under.

2.08 EXPANSION JOINTS - STEEL WITH PACKED SLIDING SLEEVE

A. Working Pressure and Temperature: Class 150.

B. Joint: As specified for pipe joints.

C. Size: Use pipe sized units.

D. Application: Steel piping 2 inches and over.

2.09 EXPANSION JOINTS - COPPER WITH PACKED SLIDING SLEEVE

A. Working Pressure: 125 psi.

B. Maximum Temperature: 250 degrees F.

C. Joint: As specified for pipe joints.
D. Size: Use pipe sized units.
E. Application: Copper or steel piping 2 inches and over.

2.10 ACCESSORIES
A. Stainless Steel Pipe: ASTM A269.
B. Pipe Alignment Guides:
   1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame
      with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches
      travel.
C. Swivel Joints:
   1. Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N)
      o-ring seals.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line
   size flexible connectors.
D. Install flexible connectors at right angles to displacement. Install one end immediately adjacent
   to isolated equipment and anchor other end. Install in horizontal plane unless indicated
   otherwise.
E. Anchor pipe to building structure where indicated. Provide pipe guides so movement is
   directed along axis of pipe only. Erect piping such that strain and weight is not on cast
   connections or apparatus.
F. Provide support and equipment required to control expansion and contraction of piping.
   Provide loops, pipe offsets, and swing joints, or expansion joints where required.
G. Substitute grooved piping for vibration isolated equipment instead of flexible connectors.
   Grooved piping need not be anchored.

END OF SECTION
SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Pressure gage taps.
   B. Thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS
   A. Section 23 21 13 - Hydronic Piping.
   B. Section 23 09 23 - Direct-Digital Control System for HVAC.
   C. Section 23 09 93 - SEQUENCE OF OPERATIONS FOR HVAC CONTROLS.

1.03 REFERENCE STANDARDS
   A. ASME B40.100 - Pressure Gauges and Gauge Attachments.
   D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.

1.04 SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
   C. Samples: Submit one of each type of instrument specified.
   D. Project Record Documents: Record actual locations of components and instrumentation.
   E. Operation and Maintenance Data: pressure gages, thermometers, static pressure gages.

1.05 FIELD CONDITIONS
   A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAGES
   A. Manufacturers:
   B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
      1. Case: Steel with brass bourdon tube.
      2. Size: 4-1/2 inch diameter.
      3. Mid-Scale Accuracy: One percent.
      4. Scale: Psi and KPa.

2.02 PRESSURE GAGE TAPPINGS
   A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.
   B. Needle Valve: Brass or stainless steel 1/4 inch NPT for minimum 150 psi.
   C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.
D. Syphon: Brass, Stainless Steel or Bronze 1/4 inch angle or straight pattern.

2.03 STEM TYPE THERMOMETERS

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Thermometers - Fixed Mounting: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish.
1. Size: 7 inch scale.
2. Window: Clear Lexan.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F and Degrees C.

C. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
1. Size: 7 inch scale.
2. Window: Clear Lexan.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F and Degrees C.

2.04 DIAL THERMOMETERS

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
1. Size: 2 inch diameter dial.
2. Lens: Clear Lexan.
3. Accuracy: 1 percent.
4. Calibration: Degrees F and Degrees C.

C. Thermometer: ASTM E1, stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
1. Size: 3 inch diameter dial.
2. Lens: Clear Lexan.
3. Accuracy: 1 percent.
4. Calibration: Degrees F and Degrees C.

D. Thermometers: Dial type vapor or liquid actuated; ASTM E1; stainless steel case, with brass or copper bulb, copper or bronze braided capillary, white with black markings and black pointer, glass lens.
1. Size: 2-1/2 inch diameter dial.
2. Lens: Clear Lexan.
3. Length of Capillary: Minimum 5 feet.
4. Accuracy: 2 percent.
5. Calibration: Degrees F and Degrees C.

2.05 THERMOMETER SUPPORTS
A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.06 TEST PLUGS
A. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.
B. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Nordel core for temperatures up to 350 degrees F.
C. Test Plug: 1/4 inch or 1/2 inch brass or stainless steel fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with Viton core for temperatures up to 400 degrees F.
D. Test Kit: Carrying case, internally padded and fitted containing one 2-1/2 inch diameter pressure gages, one gage adapters with 1/8 inch probes, two 1-1/2 inch dial thermometers.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gage. Extend nipples to allow clearance from insulation.
D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets. Refer to Section 23 09 23. Where thermometers are provided on local panels, duct or pipe mounted thermometers are provided on local panels, duct or pipe mounted thermometers are not required.
F. Coil and conceal excess capillary on remote element instruments.
G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.
J. Locate test plugs adjacent thermometers and thermometer sockets, adjacent to pressure gages and pressure gage taps, adjacent to control device sockets and where indicated.

3.02 SCHEDULE
A. Pressure Gages, Location and Scale Range:
   1. Pumps, 0 to 225 psi.
2. Expansion tanks, 0 to 225 psi.
3. Pressure tanks, 0 to 225 psi.

B. Pressure Gage Tappings, Location:
   3. Chiller - inlets and outlets.

C. Stem Type Thermometers, Location and Scale Range:
   1. Headers to central equipment, 0 to 220 degrees F.
   2. Coil banks - inlets and outlets, 0 to 220 degrees F.
   3. After major coils, 0 to 220 degrees F.

D. Thermometer Sockets, Location:
   1. Control valves 1 inch & larger - inlets and outlets.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES
A. Vibration isolators.

1.02  SUBMITTALS
A. Product Data: Provide schedule of vibration isolator type with location and load on each.
B. Shop Drawings: Indicate inertia bases and locate vibration isolators, with static and dynamic load on each. Indicate seismic control measures.
C. Manufacturer's Instructions: Indicate installation instructions with special procedures and setting dimensions.

PART 2  PRODUCTS

2.01  MANUFACTURERS
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02  PERFORMANCE REQUIREMENTS
A. General:
   1. All vibration isolators, base frames and inertia bases to conform to all uniform deflection and stability requirements under all operating loads.
   2. Steel springs to function without undue stress or overloading.

2.03  VIBRATION ISOLATORS
A. Open Spring Isolators:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
B. Restrained Open Spring Isolators:
   1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
   2. Spring Mounts: Provide with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
   3. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
   4. Restraint: Provide heavy mounting frame and limit stops.
   5. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.
C. Closed Spring Isolators:
1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

D. Restrained Closed Spring Isolators:
1. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

E. Spring Hangers:
1. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection. Color code springs for load carrying capacity.
2. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators.
4. For Exterior and Humid Areas: Hot dipped galvanized housings and neoprene coated springs.

F. Neoprene Pad Isolators:
1. Rubber or neoprene waffle pads.
   a. Hardness: 30 durometer.
   b. Thickness: Minimum 1/2 inch.
   c. Maximum Loading: 50 psi.
   d. Rib Height: Maximum 0.7 times width.
3. Configuration: 1/2 inch thick waffle pads bonded each side of 1/4 inch thick steel plate.

G. Rubber Mount or Hanger: Molded rubber designed for 0.4 inch deflection with threaded insert.

H. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

I. Seismic Snubbers:
1. Type: Non-directional and double acting unit consisting of interlocking steel members restrained by neoprene elements.
2. Elements: Replaceable neoprene, minimum of 0.75 inch thick with minimum 1/8 inch air gap.
3. Capacity: 4 times load assigned to mount groupings at 0.4 inch deflection.
4. Attachment Points and Fasteners: Capable of withstanding 3 times rated load capacity of seismic snubber.

J. Roof Mounting Curb: 14 inches high with rigid steel lower section containing adjustable spring pockets with restrained spring isolators, steel upper section to support rooftop equipment, and continuous elastomeric membrane extending from upper section for counterflashing over
roofing. Provide acoustical package consisting of interior perimeter angles and cross members to support up to two layers of gypsum board.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

B. Bases:
   1. Set steel bases for one inch clearance between housekeeping pad and base.
   2. Set concrete inertia bases for 2 inches clearance between housekeeping pad and base.
   3. Adjust equipment level.

C. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

D. 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.

E. Provide pairs of horizontal limit springs on fans with more than 6.0 inches WC static pressure, and on hanger supported, horizontally mounted axial fans.

F. Provide seismic snubbers for all equipment, piping, and ductwork mounted on isolators. Each inertia base shall have minimum of four seismic snubbers located close to isolators. Snub equipment designated for post-disaster use to 0.05 inch maximum clearance. Other snubbers shall have clearance between 0.15 inch and 0.25 inch.

G. Support piping connections to equipment mounted on isolators using isolators or resilient hangers as follows:
   1. Up to 4 Inches Pipe Size: First three points of support.
   2. 5 to 8 Inches Pipe Size: First four points of support.
   3. 10 inches Pipe Size and Over: First six points of support.
   4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.02 FIELD QUALITY CONTROL

A. Inspect isolated equipment after installation and submit report. Include static deflections.

3.03 SCHEDULE

A. Pipe Isolation Schedule.
   1. 1 Inch Pipe Size: Isolate 120 diameters from equipment.
   2. 2 Inch Pipe Size: Isolate 90 diameters from equipment.
   3. 3 Inch Pipe Size: Isolate 80 diameters from equipment.
   4. 4 Inch Pipe Size: Isolate 75 diameters from equipment.
   5. 6 Inch Pipe Size: Isolate 60 diameters from equipment.
   6. 8 Inch Pipe Size: Isolate 60 diameters from equipment.
   7. 10 Inch Pipe Size: Isolate 54 diameters from equipment.
   8. 12 Inch Pipe Size: Isolate 50 diameters from equipment.
   9. 16 Inch Pipe Size: Isolate 45 diameters from equipment.
   10. 24 Inch Pipe Size: Isolate 38 diameters from equipment.
   11. Over 24 Inch Pipe Size: As indicated.

B. Equipment Isolation Schedule.
   1. HVAC Pumps.
      a. Base: Concrete inertia base.
b. Isolator Type: Open Spring Isolators

END OF SECTION
SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Nameplates.
   B. Tags.
   C. Stencils.
   D. Pipe Markers.

1.02 RELATED REQUIREMENTS
   A. Section 09 90 00 - Painting and Coating: Identification painting.

1.03 REFERENCE STANDARDS

1.04 SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. List: Submit list of wording, symbols, letter size, and color coding for mechanical identification.
   C. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
   D. Product Data: Provide manufacturers catalog literature for each product required.
   E. Samples: Submit two labels, tags and pipe markers.
   F. Manufacturer's Installation Instructions: Indicate special procedures, and installation.
   G. Project Record Documents: Record actual locations of tagged valves.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS
   A. Air Handling Units: Nameplates.
   B. Air Terminal Units: Nameplates.
   C. Control Panels: Nameplates.
   D. Dampers: Ceiling tacks, where located above lay-in ceiling.
   E. Ductwork: Stencilled painting.
   F. Major Control Components: Nameplates.
   G. Piping: Pipe markers.
   H. Thermostats: Nameplates.
   I. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 MANUFACTURERS
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 NAMEPLATES
   A. Description: Laminated three-layer plastic with engraved letters.
2. Letter Height: 1/4 inch.

2.04 TAGS
   A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
   B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.05 STENCILS
   A. Stencils: With clean cut symbols and letters of following size:
      1. Ductwork and Equipment: 2-1/2 inch high letters.
   B. Stencil Paint: As specified in Section 09 90 00, semi-gloss enamel, colors conforming to ASME A13.1.

2.06 PIPE MARKERS
   B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
   C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
   D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.07 CEILING TACKS
   A. Description: Steel with 3/4 inch diameter color coded head.
   B. Color code as follows:
      1. HVAC Equipment: Yellow.
      2. Fire Dampers and Smoke Dampers: Red.

PART 3 EXECUTION

3.01 PREPARATION
   A. Degrease and clean surfaces to receive adhesive for identification materials.
   B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

3.02 INSTALLATION
   A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
   B. Install tags with corrosion resistant chain.
   C. Apply stencil painting in accordance with Section 09 90 00.
   D. Install plastic pipe markers in accordance with manufacturer’s instructions.
   E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer’s instructions.
   F. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
   G. Identify air handling units, pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.
H. Identify control panels and major control components outside panels with plastic nameplates.
I. Identify thermostats relating to terminal boxes or valves with nameplates.
J. Identify valves in main and branch piping with tags.
K. Identify air terminal units and radiator valves with numbered tags.
L. Tag automatic controls, instruments, and relays. Key to control schematic.
M. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
N. Identify ductwork with plastic nameplates or stencilled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
O. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

### 3.03 UNIT TAG SCHEDULE

**A. Equipment Type: Variable - Air Volume Units (VAV)**

1. Identification: Tag (VAV-X) where X = VAV number. Include Flow Rates (GPM and Max/Min CFM)
2. Background:
   a. Size: As needed to contain information
   b. Color: White
3. Lettering:
   a. Size: 1/4 inch high
   b. Color: Black
4. Placement: As directed by Architect/Engineer

**B. Equipment Type: Rooftop Mounted Air Handling Unit (RTU)**

1. Identification: Tag (RTU-X) where X = Unit number. Include manufacturer, model number, serial number, date of manufacturer start-up, date of manufacture, refrigerant type (if applicable), voltage, frequency, phase.
2. Background:
   a. Size: As needed to contain information
   b. Color: White
3. Lettering:
   a. Size: 1/4 inch high
   b. Color: Black
4. Placement: As directed by Architect/Engineer

**C. Equipment Type: Exhaust Fan (EF)**

1. Identification: Tag (EF-X) where X = Unit number. Include manufacturer, model number, serial number, voltage, frequency, phase.
2. Background:
   a. Size: As needed to contain information
   b. Color: White
3. Lettering:
   a. Size: 1/4 inch high
   b. Color: Black
4. Placement: As directed by Architect/Engineer

END OF SECTION
SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Testing, adjustment, and balancing of air systems.
B. Testing, adjustment, and balancing of hydronic and refrigerating as applicable systems.
C. Measurement of final operating condition of HVAC systems.

1.02 RELATED REQUIREMENTS
A. Section 23 08 00 - Commissioning of HVAC.

1.03 REFERENCE STANDARDS
A. AABC MN-1 - AABC National Standards for Total System Balance; Associated Air Balance Council.
C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems.
D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing.

1.04 SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
   1. Submit to the Commissioning Authority.
   2. Submit six weeks prior to starting the testing, adjusting, and balancing work.
   3. Include certification that the plan developer has reviewed the contract documents, the equipment and systems, and the control system with the Architect and other installers to sufficiently understand the design intent for each system.
   4. Include at least the following in the plan:
      a. Preface: An explanation of the intended use of the control system.
      b. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
      c. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
      d. Identification and types of measurement instruments to be used and their most recent calibration date.
      e. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
      f. Final test report forms to be used.
      g. Detailed step-by-step procedures for TAB work for each system and issue, including:
         1) Terminal flow calibration (for each terminal type).
         2) Diffuser proportioning.
         3) Branch/submain proportioning.
         4) Total flow calculations.
         5) Rechecking.
6) Diversity issues.
   h. Expected problems and solutions, etc.
   i. Criteria for using air flow straighteners or relocating flow stations and sensors; analogous explanations for the water side.
   j. Details of how TOTAL flow will be determined; for example:
      1) Air: Sum of terminal flows via control system calibrated readings or via hood readings of all terminals, supply (SA) and return air (RA) pitot traverse, SA or RA flow stations.
      2) Water: Pump curves, circuit setter, flow station, ultrasonic, etc.
   k. Specific procedures that will ensure that both air and water side are operating at the lowest possible pressures and methods to verify this.
   l. Confirmation of understanding of the outside air ventilation criteria under all conditions.
   m. Method of verifying and setting minimum outside air flow rate will be verified and set and for what level (total building, zone, etc.).
   n. Method of checking building static and exhaust fan and/or relief damper capacity.
   o. Proposed selection points for sound measurements and sound measurement methods.
   p. Methods for making coil or other system plant capacity measurements, if specified.
   q. Time schedule for TAB work to be done in phases (by floor, etc.).
   r. Description of TAB work for areas to be built out later, if any.
   s. Time schedule for deferred or seasonal TAB work, if specified.
   t. False loading of systems to complete TAB work, if specified.
   u. Exhaust fan balancing and capacity verifications, including any required room pressure differentials.
   v. Interstitial cavity differential pressure measurements and calculations, if specified.
   w. Procedures for field technician logs of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed tests (scope and frequency).
   x. Procedures for formal progress reports, including scope and frequency.
   y. Procedures for formal deficiency reports, including scope, frequency and distribution.

D. Field Logs: Submit at least twice a week to Studio JAED; Commissioning Authority and HVAC Controls Contractor.

E. Control System Coordination Reports: Communicate in writing to the controls installer all setpoint and parameter changes made or problems and discrepancies identified during TAB that affect, or could affect, the control system setup and operation.

F. Progress Reports.

G. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
   1. Submit to the Commissioning Authority; Studio JAED and HVAC Controls Contractor within two weeks after completion of testing, adjusting, and balancing.
   2. Revise TAB plan to reflect actual procedures and submit as part of final report.
   3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
   4. Provide reports in hard cover letter size 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
   5. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
6. **Form of Test Reports:** Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
7. **Units of Measure:** Report data in I-P (inch-pound) units only.
8. Include the following on the title page of each report:
   a. Name of Testing, Adjusting, and Balancing Agency.
   b. Address of Testing, Adjusting, and Balancing Agency.
   c. Telephone number of Testing, Adjusting, and Balancing Agency.
   d. Project name.
   e. Project location.
   f. Project Engineer.
   g. Project altitude.
   h. Report date.

H. **Project Record Documents:** Record actual locations of flow measuring stations and balancing valves and rough setting.

**PART 2 PRODUCTS - NOT USED**

**PART 3 EXECUTION**

3.01 **GENERAL REQUIREMENTS**

A. **Perform total system balance in accordance with one of the following:**
   1. AABC MN-1, AABC National Standards for Total System Balance.
   3. SMACNA (TAB).
   4. Maintain at least one copy of the standard to be used at project site at all times.

B. **Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.**

C. **Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.**

D. **TAB Agency Qualifications:**
   1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
   2. Having minimum of three years documented experience.
   3. Certified by one of the following:
      b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.

E. **TAB Supervisor Qualifications:** Professional Engineer licensed in the State in which the Project is located.

3.02 **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 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 that will or could prevent proper system balance.

C. Beginning of work means acceptance of existing conditions.

3.03 PREPARATION
A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
   1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.
C. Provide additional balancing devices as required.

3.04 ADJUSTMENT TOLERANCES
A. Air Handling Systems: Adjust to within plus or minus 10 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 10 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.05 RECORDING AND ADJUSTING
A. Field Logs: Maintain written logs including:
   1. Running log of events and issues.
   2. Discrepancies, deficient or uncompleted work by others.
   4. Lists of completed tests.
B. Ensure recorded data represents actual measured or observed conditions.
C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
D. Mark on drawings the locations where traverse and other critical measurements were taken and cross reference the location in the final report.
E. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.
H. Check and adjust systems approximately six months after final acceptance and submit report.
3.06 AIR SYSTEM PROCEDURE

A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.

B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

C. Measure air quantities at air inlets and outlets.

D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.

E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.

F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.

G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.

H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.

I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.

J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.

L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.05 inches positive static pressure near the building entries.

M. Check multi-zone units for motorized damper leakage. Adjust air quantities with mixing dampers set first for cooling, then heating, then modulating.

N. For variable air volume system powered units set volume controller to air flow setting indicated. Confirm connections properly made and confirm proper operation for automatic variable air volume temperature control.

O. On fan powered VAV boxes, adjust air flow switches for proper operation.

3.07 SCOPE

A. Test, adjust, and balance the following:
   1. Air Coils.
   2. Air Handling Units / Energy Recovery Ventilators
   3. Air Terminal Units.
   4. Air Inlets and Outlets.
   5. Electric Duct Heating Coils

3.08 MINIMUM DATA TO BE REPORTED

A. Electric Motors:
   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

B. V-Belt Drives:
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

C. Heating Coils:
1. Identification/number
2. Location
3. Service
4. Manufacturer
5. Air flow, design and actual
6. Entering air temperature, design and actual
7. Leaving air temperature, design and actual
8. Air pressure drop, design and actual

D. Electric Duct Heaters:
1. Manufacturer.
2. Identification/number.
3. Location.
4. Model number.
5. Design kW.
6. Number of stages.
7. Phase, voltage, amperage.
8. Test voltage (each phase).
10. Air flow, specified and actual.
11. Temperature rise, specified and actual.

E. Air Moving Equipment:
1. Location
2. Manufacturer
3. Model number
4. Serial number
5. Arrangement/Class/Discharge
6. Air flow, specified and actual
7. Return air flow, specified and actual
8. Outside air flow, specified and actual
9. Total static pressure (total external), specified and actual
10. Inlet pressure
11. Discharge pressure
12. Sheave Make/Size/Bore
13. Number of Belts/Make/Size
14. Fan RPM

F. Return Air/Outside Air:
1. Identification/location
2. Design air flow
3. Actual air flow
4. Design return air flow
5. Actual return air flow
6. Design outside air flow
7. Actual outside air flow
8. Return air temperature
9. Outside air temperature
10. Required mixed air temperature
11. Actual mixed air temperature
12. Design outside/return air ratio
13. Actual outside/return air ratio

G. Exhaust Fans:
   1. Location.
   2. Manufacturer.
   3. Model number.
   4. Serial number.
   5. Air flow, specified and actual.
   6. Total static pressure (total external), specified and actual.
   7. Inlet pressure.
   8. Discharge pressure.
   10. Number of Belts/Make/Size.
   11. Fan RPM.

H. Duct Traverses:
   1. System zone/branch
   2. Duct size
   3. Area
   4. Design velocity
   5. Design air flow
   6. Test velocity
   7. Test air flow
   8. Duct static pressure
   9. Air temperature
   10. Air correction factor

END OF SECTION
SECTION 23 07 13
DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Duct insulation.
B. Insulation jackets.

1.02 RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating: Painting insulation jackets.
B. Section 23 05 53 - Identification for HVAC Piping and Equipment.
C. Section 23 31 00 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS
K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

1.04 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Manufacturer's Instructions: Indicate installation procedures necessary to ensure acceptable workmanship and that installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section, with minimum three years of experience and approved by manufacturer.
1.06 DELIVERY, STORAGE, AND HANDLING
   A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
   B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.07 FIELD CONDITIONS
   A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
   B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
   A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER, FLEXIBLE
   A. Manufacturer:
   B. Insulation: ASTM C553; flexible, noncombustible blanket.
      1. 'K' value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
      2. Maximum Service Temperature: 450 degrees F.
      3. Maximum Water Vapor Sorption: 5.0 percent by weight.
   C. Vapor Barrier Jacket:
      1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
      2. Secure with pressure sensitive tape.
   D. Vapor Barrier Tape:
      1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
   E. Outdoor Vapor Barrier Mastic:
      1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
   F. Tie Wire: Annealed steel, 16 gage, 0.0508 inch diameter.

2.03 GLASS FIBER, RIGID
   A. Manufacturer:
      5. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Insulation: ASTM C612; rigid, noncombustible blanket.
      1. 'K' value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
      2. Maximum service temperature: 450 degrees F.
      3. Maximum Water Vapor Sorption: 5.0 percent.

C. Vapor Barrier Jacket:
   1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
   2. Secure with pressure sensitive tape.

D. Vapor Barrier Tape:
   1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

E. Indoor Vapor Barrier Finish:
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

2.04 JACKETS

A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
   1. Lagging Adhesive:
      a. Compatible with insulation.

B. Mineral Fiber (Outdoor) Jacket: Asphalt impregnated and coated sheet, 50 lb/square.

   1. Thickness: 0.016 inch sheet.
   2. Finish: Smooth.
   4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
   5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.
   6. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that ducts have been tested before applying insulation materials.
B. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Insulated ducts conveying air below ambient temperature:
   1. Provide insulation with vapor barrier jackets.
   2. Finish with tape and vapor barrier jacket.
   3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
   4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

D. Insulated ducts conveying air above ambient temperature:
   1. Provide with or without standard vapor barrier jacket.
   2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

E. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

F. Exterior Applications: Provide insulation with vapor barrier jacket. Cover with with calked aluminum jacket with seams located on bottom side of horizontal duct section.
G. External Duct Insulation Application:
1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
2. Secure insulation without vapor barrier with staples, tape, or wires.
3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

H. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
4. Seal liner surface penetrations with adhesive.
5. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES
A. INDOOR DUCT AND PLENUM APPLICATION SCHEDULE
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
   a. Material: Mineral-fiber blanket
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
4. Service: Rectangular, supply-air ducts, concealed.
   a. Material: Mineral-fiber blanket
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
5. Service: Rectangular, return-air ducts, concealed.
   a. Material: Mineral-fiber blanket
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
   a. Material: Mineral-fiber blanket
   b. Thickness: 2 inches, R-6 minimum.
   c. Jacket: Foil and paper.
   d. Vapor Retarder Required: Yes.
7. Service: Round, supply-air ducts, exposed.
a. Material: Mineral-fiber blanket  
b. Thickness: 2 inches, R-6 minimum.  
c. Jacket: Aluminum, painted to architects specifications.  
d. Vapor Retarder Required: Yes.  
e. NOTE: Provide double-walled spiral ductwork in areas exposed to view in finished areas and where noted.

b. Thickness: 2 inches, R-6 minimum.  
c. Jacket: Aluminum, painted to architects specifications.  
d. Vapor Retarder Required: Yes.  
e. NOTE: Provide double-walled spiral ductwork in areas exposed to view in finished areas and where noted.

b. Thickness: 2 inches, R-6 minimum.  
c. Jacket: Aluminum, painted to architects specifications.  
d. Vapor Retarder Required: Yes.  
e. NOTE: Provide double-walled spiral ductwork in areas exposed to view in finished areas and where noted.

10. Service: Rectangular, supply-air ducts, exposed.  
b. Thickness: 2 inches, R-6 minimum.  
c. Jacket: Aluminum, painted to architects specifications.  
d. Vapor Retarder Required: Yes.  

11. Service: Rectangular, return-air ducts, exposed.  
b. Thickness: 2 inches, R-6 minimum.  
c. Jacket: Aluminum, painted to architects specifications.  
d. Vapor Retarder Required: Yes.  

12. Service: Rectangular, outside-air ducts, exposed.  
b. Thickness: 2 inches, R-6 minimum.  
c. Jacket: Aluminum, painted to architects specifications.  
d. Vapor Retarder Required: Yes.  

d. Vapor Retarder Required: No.

a. Material: Calcium silicate.  
b. Thickness: 2 inches.  
c. Field Applied Jacket: Glass cloth.  
d. Vapor Retarder Required: No.

a. Material: Calcium silicate.  
b. Thickness: 2 inches.  
d. Vapor Retarder Required: No.

15. Service: Rectangular, dishwasher exhaust ducts, concealed.  
b. Thickness: 1 inch.  
c. Jacket: Foil and Paper  
d. Vapor Retarder Required: No.
   b. Thickness: 1 inch.
   c. Jacket: Aluminum
   d. Vapor Retarder Required: No.

END OF SECTION
SECTION 23 07 19
HVAC PIPING INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Piping insulation.
   B. Jackets and accessories.

1.02 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping.
   B. Section 09 90 00 - Painting and Coating: Painting insulation jacket.
   C. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.
   D. Section 23 23 00 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS
   A. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   M. ASTM C585 - Standard Practice for Inner and Outer Diameters of Thermal Insulation for Nominal Sizes of Pipe and Tubing.
V. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.04 SUBMITTALS
A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
B. Manufacturer's Instructions: Indicate installation procedures that ensure acceptable workmanship and installation standards will be achieved.

1.05 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.
B. Applicator Qualifications: Company specializing in performing the type of work specified in this section with minimum three years of experience.

1.06 DELIVERY, STORAGE, AND HANDLING
A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.07 FIELD CONDITIONS
A. Maintain ambient conditions required by manufacturers of each product.
B. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 PRODUCTS
2.01 REQUIREMENTS FOR ALL PRODUCTS OF THIS SECTION
A. Surface Burning Characteristics: Flame spread/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84, NFPA 255, or UL 723.

2.02 GLASS FIBER
A. Manufacturers:
B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 850 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
   1. 'K' value: ASTM C177, 0.24 at 75 degrees F.
   2. Maximum service temperature: 650 degrees F.
   3. Maximum moisture absorption: 0.2 percent by volume.
D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
E. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
F. Vapor Barrier Lap Adhesive:  
   1. Compatible with insulation.

G. Insulating Cement/Mastic:  
   1. ASTM C195; hydraulic setting on mineral wool.

H. Fibrous Glass Fabric:  
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Blanket: 1.0 lb/cu ft density.
   3. Weave: 5x5.

I. Indoor Vapor Barrier Finish:  
   1. Cloth: Untreated; 9 oz/sq yd weight.
   2. Vinyl emulsion type acrylic, compatible with insulation, black color.

J. Outdoor Vapor Barrier Mastic:  
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

K. Outdoor Breather Mastic:  
   1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

L. Insulating Cement:  
   1. ASTM C449/C449M.

2.03 CELLULAR GLASS

A. Manufacturers:  
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: ASTM C552, Type 1.  
   1. Apparent Thermal Conductivity; 'K' value: Grade 6, 0.33 at 100 degrees F.  
   2. Service Temperature: Up to 800 degrees F.  
   3. Water Vapor Permeability: 0.005 perm inch.  
   4. Water Absorption: 0.5 percent by volume, maximum.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

A. Manufacturer:  
   1. Armacell LLC: www.armacell.us.  
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 3; use molded tubular material wherever possible.  
   1. Minimum Service Temperature: -40 degrees F.  
   2. Maximum Service Temperature: 220 degrees F.  

C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that piping has been tested before applying insulation materials.
B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.
B. Install in accordance with NAIMA National Insulation Standards.
C. Exposed Piping: Locate insulation and cover seams in least visible locations.
D. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.

E. Glass fiber insulated pipes conveying fluids below ambient temperature:
   1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
   2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.

F. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.

G. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.

H. Glass fiber insulated pipes conveying fluids above ambient temperature:
   1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
   2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

I. Inserts and Shields:
   1. Application: Piping 1-1/2 inches diameter or larger.
   2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
   3. Insert location: Between support shield and piping and under the finish jacket.
   4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
   5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.

J. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.

K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

3.03 SCHEDULE

A. PIPING INSULATION SCHEDULES
   1. General: Abbreviations used in the following schedules include:

B. INTERIOR PIPING APPLICATION SCHEDULE

C. Service: Heating hot-water supply and return.
   1. Operating Temperature: 100 to 250 deg F.
   2. Insulation Material: Mineral fiber or glass fiber.
   3. Insulation Thickness: Apply the following insulation thicknesses:
END OF SECTION
SECTION 23 09 13
INSTRUMENTATION AND CONTROL DEVICES FOR HVAC

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Thermostats, Temperature Sensors.
B. Automatic dampers.
C. Damper operators.
D. Miscellaneous accessories.

1.02 RELATED REQUIREMENTS
A. Section 23 21 13 - Hydronic Piping: Installation of control valves, flow switches, temperature sensor sockets, gage taps.
B. Section 23 33 00 - Air Duct Accessories: Installation of automatic dampers.
C. Section 23 09 23 - Direct-Digital Control System for HVAC.
D. Section 23 09 93 - Sequence Of Operations

1.03 REFERENCE STANDARDS
A. Input/Output Sensors:
B. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating.
C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
H. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum); National Electrical Manufacturers Association.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Preinstallation Meeting: Conduct a preinstallation meeting one week before starting work of this section; require attendance by all affected installers.
B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide description and engineering data for each control system component. Include sizing as requested. Provide data for each system component and software module.
C. Shop Drawings: Indicate complete operating data, system drawings, wiring diagrams, and written detailed operational description of sequences. Submit schedule of valves indicating size, flow, and pressure drop for each valve. For automatic dampers indicate arrangement, velocities, and static pressure drops for each system.
D. Manufacturer’s Instructions: Provide for all manufactured components.
E. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
1. Revise shop drawings to reflect actual installation and operating sequences.

F. Operation and Maintenance Data: Include inspection period, cleaning methods, recommended cleaning materials, and calibration tolerances.

G. Project Record Documents: Record actual locations of control components, including panels, thermostats, and sensors. Accurately record actual location of control components, including panels, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.

H. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.

1.06 QUALITY ASSURANCE

A. Designer Qualifications: Design system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State in which the Project is located.

B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 EQUIPMENT - GENERAL

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.02 CONTROL PANELS

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B. NEMA 250, general purpose utility enclosures with enamelled finished face panel.

C. Provide common keying for all panels.

2.03 DAMPERS

A. Performance: Test in accordance with AMCA 500-D.

B. Frames: Galvanized steel, welded or riveted with corner reinforcement, minimum 12 gage.

C. Blades: Galvanized steel, maximum blade size 8 inches wide, 48 inches long, minimum 22 gage, attached to minimum 1/2 inch shafts with set screws.

D. Blade Seals: Synthetic elastomeric inflatable mechanically attached, field replaceable.

E. Jamb Seals: Spring stainless steel.

F. Shaft Bearings: Oil impregnated sintered bronze.

G. Linkage Bearings: Oil impregnated sintered bronze.

H. Leakage: Less than one percent based on approach velocity of 2000 ft/min and 4 inches wg.

I. Maximum Pressure Differential: 6 inches wg.

J. Temperature Limits: -40 to 200 degrees F.
2.04 DAMPER OPERATORS

A. General: Provide smooth proportional control with sufficient power for air velocities 20 percent greater than maximum design velocity and to provide tight seal against maximum system pressures. Provide spring return for two position control and for fail safe operation.

1. Provide sufficient number of operators to achieve unrestricted movement throughout damper range.
2. Provide one operator for maximum 36 sq ft damper section.

B. Electric Operators:

1. Spring return, adjustable stroke motor having oil immersed gear train, with auxiliary end switch.

2.05 INPUT/OUTPUT SENSORS

A. Temperature Sensors:

1. Room temperature sensors shall be field-installed flat plate sensors with no possible adjustment or display. VRF unit controllers shall be mounted above the ceiling at the unit and a flat-plate temperature sensor is to be extended and wall-mounted within the space by the BAS contractor. Security screws shall be used in institutional settings as deemed necessary by the design engineer. ATC contractor shall coordinate requirements with the design engineer during the submittal process. Provide insulated base. Following sensing elements are acceptable:

   a. Sensing element - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.

2. Single point duct temperature sensor shall consist of sensing element, junction box for wiring connections and gasket to prevent air leakage or vibration noise. Temperature range as required for resolution indicated in paragraph A. Sensor probe shall be 316 stainless steel.

   a. Sensing element - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.

3. Averaging duct temperature sensor shall consist of an averaging element, junction box for wiring connections and gasket to prevent air leakage. Provide enough sensors to give one lineal foot of sensing element for each square foot of cooling coil face area. Temperature range as required for resolution indicated in paragraph A.

   a. Sensing element - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point.

4. Liquid immersion temperature sensor shall include stainless steel thermowell, sensor and connection head for wiring connections.

   a. Sensing element for chilled water applications - Platinum RTD, Thermistor, or integrated circuit, +/- 0.8°F accuracy at calibration point. Temperature range shall be as required for resolution indicated in paragraph A.

   b. Sensing element for non-chilled water applications - Platinum RTD, +/- 0.2°F accuracy at calibration point. Temperature range shall be as required for resolution of no worse than 0.1°F.

5. Room Sensors:

Covers: Locking with slide-bar set point adjustment, and concealed setpoint, without thermometer.

B. Humidity Sensors:

1. Duct Mounted Sensor: Voltage type encased in a die-cast metal, weather-proof housing.

   a. Input Power, Voltage Type: Class 2; 12-30 VDC/24 VAC, 15mA max.

   b. Input Power, mA Type: Class 2; Loop powered 12-30 VDC only, 30 mA max.

   c. Output Voltage type: 3-wire observed polarity.

   d. Output mA type: 2-wire, not polarity sensitive (clipped and capped).

   e. Humidity:
1) **HS Element:** Digitally profiled thin-film capacitive.
2) **Accuracy** 1 percent at 10 to 90 percent relative humidity at 77 degrees F, multi-point calibration, NIST traceable.
   (a) Plus/minus 1 percent at 20-40 percent RH in mA output mode; (multi-point calibration, NIST traceable).
3) **Scaling:** 0-100 percent RH.

**f. Temperature Effect:**
1) **Duct Mounted:** Plus/minus 0.18 percent per degree F.
2) **Outdoor Mounted:** 4-20mA version: \((0.0013x\%RH \times (T_{\text{degreeC}} - 25))\).

**g. Hysteresis:** 1.5 percent typical.

**h. Linearity:** Included in accuracy specification.

**i. Reset Rate:** 24 hours.

**j. Stability:** Plus/minus 1 percent @ 68 degrees F (20 degrees C) annually, for two years.

**k. Temperature Monitoring:**
1) **Temperature Transmitter Output:** Digital, 4-20mA (clipped & capped) or 0-5V/0-10V output.
   (a) **HO Transmitter Accuracy:** Plus/minus 2.3 degrees F.
   (b) **HD Transmitter Accuracy:** Plus/minus 1.0 degree F.

**l. Operating Environment:**
1) **Operating Humidity Range:** 0 to 100 percent RH noncondensing.
2) **Operating Temperature Range:** Minus 40 degrees F to 122 degrees F.

2. **Wall Mounted Sensor:** Voltage type encased in a high impact ABS plastic housing.
   **a. Input Power, Voltage Type:** Class 2; 12-24 VDC/24 VAC.

3. **Elements:** Accurate within 5 percent full range with linear output.

4. **Room Sensors:** With locking cover, span of 10 to 60 percent relative humidity.

5. **Duct and Outside Air Sensors:** With element guard and mounting plate, range of 0 - 100 percent relative humidity.

**C. Damper Position Indication:** Potentiometer mounted in enclosure with adjustable crank arm assembly connected to damper to transmit 0 - 100 percent damper travel.

**D. Equipment Operation Sensors:**
1. **Status Inputs for Fans:** Differential pressure switch with adjustable range of 0 to 5 inches wg.
2. **Status Inputs for Pumps:** Differential pressure switch piped across pump with adjustable pressure differential range of 8 to 60 psi.
3. **Status Inputs for Electric Motors:** Current sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.

**E. Carbon Dioxide Level Sensors:**
1. Wall or duct-mounted as required by control sequence or plans.
2. **Demand-control ventilation sensor for measuring and transmitting CO2 levels ranging from 0-2,000 ppm.**
3. **Single-beam, dual-wavelength design with five-year stability for calibration.**
4. Proportional output, 4-20 mA signal.

### 2.06 THERMOSTATS

**A. Line Voltage Thermostats:**
1. Integral manual On/Off/Auto selector switch, single or two pole as required.
2. **Dead band:** Maximum 2 degrees F.
3. **Cover:** Locking with set point adjustment, with thermometer.
4. **Rating:** Motor load.
B. Outdoor Reset Thermostat:
   1. Remote bulb or bimetal rod and tube type, proportioning action with adjustable throttling range, adjustable setpoint.
   2. Scale range: -10 to 70 degrees F.

C. Airstream Thermostats:
   1. Remote bulb or bimetallic rod and tube type, proportional action with adjustable setpoint in middle of range and adjustable throttling range.
   2. Averaging service remote bulb element: 7.5 feet.

D. Electric Low Limit Duct Thermostat:
   1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below setpoint,

E. Electric High Limit Duct Thermostat:
   1. Snap acting, single pole, single throw, manual reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above setpoint,
   2. Bulb length: Minimum 20 feet.
   3. Provide one thermostat for every 20 sq ft of coil surface.

F. Fire Thermostats:
   1. UL labeled, factory set in accordance with NFPA 90A.

G. Heating/Cooling Valve Top Thermostats:
   1. Proportional acting for proportional flow, molded rubber diaphragm, remote bulb liquid filled element, direct and reverse acting at differential pressure to 25 psig, cast housing with position indicator and adjusting knob.

2.07 TRANSMITTERS
A. Pressure Transmitters:
   1. One pipe direct acting indicating type for gas, liquid, or steam service, range suitable for system, proportional electronic output.

PART 3 EXECUTION
3.01 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. Ensure installation of components is complementary to installation of similar components.
G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Check and verify location of thermostats with plans and room details before installation. Locate 48 inches above floor. Align with lighting switches, CO2 sensors, and humidistats. Refer to Section 26 27 26.
C. Mount freeze protection thermostats using flanges and element holders.
D. Mount outdoor reset thermostats and outdoor sensors indoors, with sensing elements outdoors with sun shield.

E. Provide separable sockets for liquids and flanges for air bulb elements.

F. Provide thermostats in aspirating boxes in front entrances, gymnasiums, high security areas, and where indicated.

### 3.03 MAINTENANCE

A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

B. Provide service and maintenance of control system for two years from Date of Substantial Completion.

C. Provide complete service of controls systems, including call backs, and submit written report of each service call.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. System Description
   B. Operator Interface
   C. Controllers
   D. Power Supplies and Line Filtering
   E. System Software
   F. Controller Software
   G. HVAC Control Programs
   H. Chiller Control Programs
   I. Control equipment.
   J. Software.

1.02 RELATED REQUIREMENTS
   A. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
   B. 

1.03 REFERENCE STANDARDS
   A. NFPA 70 - National Electrical Code.

1.04 SYSTEM DESCRIPTION
   A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units to integrate with the existing District-wide Niagara-based control system.
   B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
   C. Include computer software and all hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
   D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
   E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment, power transformers and electrical feeds, and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
   F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide data for each system component and software module.
   C. Shop Drawings:
1. Indicate trunk cable schematic showing programmable control unit locations, and trunk data conductors.
2. List connected data points, including connected control unit and input device.
3. Indicate system graphics indicating monitored systems, data (connected and calculated) point addresses, and operator notations. Provide demonstration diskette containing graphics.
4. Show system configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
5. Indicate description and sequence of operation of operating, user, and application software.

D. Manufacturer’s Instructions: Indicate manufacturer's installation instructions for all manufactured components.

E. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
   1. Revise shop drawings to reflect actual installation and operating sequences.
   2. Include submittals data in final "Record Documents" form.

F. Operation and Maintenance Data:
   1. Include interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
   2. Include keyboard illustrations and step-by-step procedures indexed for each operator function.
   3. Include inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

G. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE
A. Perform work in accordance with NFPA 70.
B. Design system software under direct supervision of a Professional Engineer experienced in design of this Work and licensed at the State in which the Project is located.
C. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum 10 years documented experience.
D. Installer Qualifications: Company specializing in performing the work of this section 5 years documented experience approved by manufacturer.
E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.07 PRE-INSTALLATION MEETING
A. Convene one week before starting work of this Section.
B. Require attendance of parties directly affecting the work of this Section.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Correct defective Work within a five year period after Substantial Completion.
C. Provide five year manufacturer's warranty for field programmable micro-processor based units.

1.09 MAINTENANCE SERVICE
A. Provide service and maintenance of energy management and control systems for one years from Date of Substantial Completion.
B. Provide four complete inspections per year, two in each season, to inspect, calibrate, and adjust controls as required, and submit written reports.

C. Provide complete service of systems, including call backs. Make minimum of 4 complete normal inspections of approximately 4 hours duration in addition to normal service calls to inspect, calibrate, and adjust controls, and submit written reports.

1.10 EXTRA MATERIALS
A. See Section 01 6000 - Product Requirements, for additional provisions.

1.11 PROTECTION OF SOFTWARE RIGHTS
A. Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:
   1. Limiting use of software to equipment provided under these specifications.
   2. Limiting copying.
   3. Preserving confidentiality.
   4. Prohibiting transfer to a third party.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Johnson Controls, Inc
B. Substitutions: Not Permitted.

2.02 SYSTEM DESCRIPTION
A. Automatic temperature control field monitoring and control system using field programmable micro-processor based units with communications to district-wide Building Management System.
B. Base system on distributed system of fully intelligent, stand-alone controllers, operating in a multi-tasking, multi-user environment on token passing network, with central and remote hardware, software, and interconnecting wire and conduit.
C. Include computer software and hardware, operator input/output devices, control units, local area networks (LAN), sensors, control devices, actuators.
D. Controls for variable air volume terminals, radiation, reheat coils, unit heaters, fan coils, and the like when directly connected to the control units. Individual terminal unit control is specified in Section 23 09 13.
E. Provide control systems consisting of thermostats, control valves, dampers and operators, indicating devices, interface equipment and other apparatus and accessories required to operate mechanical systems, and to perform functions specified.
F. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.

2.03 CONTROLLERS
A. BASE SCOPE OF WORK:
   1. Provide new controllers and integration of new HVAC system units and components into the existing Johnson Controls Metasys system.
B. INPUT/OUTPUT INTERFACE
   1. Hardwired inputs and outputs tie into the DDC system through building, custom application, or application specific controllers.
   2. All Input/Output Points:
      a. Protect controller from damage resulting from any point short-circuiting or grounding and from voltage up to 24 volts of any duration.
b. Provide universal type for building and custom application controllers where input or output is software designated as either binary or analog type with appropriate properties.

3. Binary Inputs:
   a. Allow monitoring of On/Off signals from remote devices.
   b. Provide wetting current of 12 mA minimum, compatible with commonly available control devices and protected against the effects of contact bounce and noise.
   c. Sense dry contact closure with power provided only by the controller.

4. Pulse Accumulation Input Objects: Conform to all requirements of binary input objects and accept up to 10 pulses per second.

5. Analog Inputs:
   a. Allow for monitoring of low voltage 0 to 10 VDC, 4 to 20 mA current, or resistance signals (thermistor, RTD).
   b. Compatible with and field configurable to commonly available sensing devices.

6. Binary Outputs:
   a. Used for On/Off operation or a pulsed low-voltage signal for pulse width modulation control.
   b. Outputs provided with three position (On/Off/Auto) override switches.
   c. Status lights for building and custom application controllers to be selectable for normally open or normally closed operation.

7. Analog Outputs:
   a. Monitoring signal provides a 0 to 10 VDC or a 4 to 20 mA output signal for end device control.
   b. Provide status lights and two position (AUTO/MANUAL) switch for building and custom application controllers with manually adjustable potentiometer for manual override on building and custom application controllers.
   c. Drift to not exceed 0.4 percent of range per year.

8. Tri State Outputs:
   a. Coordinate two binary outputs to control three point, floating type, electronic actuators without feedback.
   b. Limit the use of three point, floating devices to the following zone and terminal unit control applications:
      1) VAV or duct terminal units.
      2) Duct mounted heating coils.
      3) Zone dampers.
      4) Radiation.
   c. Control algorithms run the zone actuator to one end of its stroke once every 24 hours for verification of operator tracking.

9. System Object Capacity:
   a. System size to be expandable to twice the number of input output objects required by providing additional controllers, including associated devices and wiring.
   b. Hardware additions or software revisions for the installed operator interfaces are not to be required for future, system expansions.

2.04 POWER SUPPLIES AND LINE FILTERING

A. Power Supplies:
   1. Provide UL listed control transformers with Class 2 current limiting type or over-current protection in both primary and secondary circuits for Class 2 service as required by the NEC.
   2. Limit connected loads to 80 percent of rated capacity.
   3. Match DC power supply to current output and voltage requirements.
4. Unit to be full wave rectifier type with output ripple of 5.0 mV maximum peak to peak.
5. Regulation to be 1 percent combined line and load with 100 microsecond response time for 50 percent load changes.
6. Provide over-voltage and over-current protection to withstand a 150 percent current overload for 3 seconds minimum without trip-out or failure.
7. Operational Ambient Conditions: 32 to 120 degrees F.
8. EM/RF meets FCC Class B and VDE 0871 for Class B and MIL-STD 810 for shock and vibration.
9. Line voltage units UL recognized and CSA approved.

B. Power Line Filtering:
1. Provide external or internal transient voltage and surge suppression component for all workstations and controllers.
2. Minimum surge protection attributes:
   a. Dielectric strength of 1000 volts minimum.
   b. Response time of 10 nanoseconds or less.
   c. Transverse mode noise attenuation of 65 dB or greater.
   d. Common mode noise attenuation of 150 dB or greater at 40 to 100 Hz.

2.05 OPERATOR STATION

A. Work Station:
1. Utilize owner-provided mobile laptop for interface.

B. System Support: Minimum ten (10) work stations connected to multi-user, multi-tasking environment with concurrent capability to:
1. Access DDC network.
2. Access or control same control unit.
3. Access or modify same control unit data base.
4. Archive data, alarms, and network actions to hard disk regardless of what application programs are being currently executed.
5. Develop and edit data base.
6. Implement and tune DDC control.
7. Develop graphics.
8. Control facility.

2.06 CONTROL UNITS

A. Units: Modular in design and consisting of processor board with programmable RAM memory, local operator access and display panel, and integral interface equipment.

B. Battery Backup: For minimum of 48 hours for complete system including RAM without interruption, with automatic battery charger.

C. Control Units Functions:
1. Monitor or control each input/output point.
2. Completely independent with hardware clock/calendar and software to maintain control independently.
3. Acquire, process, and transfer information to operator station or other control units on network.
4. Accept, process, and execute commands from other control unit’s or devices or operator stations.
5. Access both data base and control functions simultaneously.
6. Record, evaluate, and report changes of state or value that occur among associated points. Continue to perform associated control functions regardless of status of network.
7. Perform in stand-alone mode:
a. Start/stop.
b. Duty cycling.
c. Automatic Temperature Control.
d. Demand control via a sliding window, predictive algorithm.
e. Event initiated control.
f. Calculated point.
g. Scanning and alarm processing.
h. Full direct digital control.
i. Trend logging.
j. Global communications.
k. Maintenance scheduling.

D. Global Communications:
   1. Broadcast point data onto network, making that information available to all other system
control units.
   2. Transmit any or all input/output points onto network for use by other control units and
utilize data from other control units.

E. Input/Output Capability:
   1. Discrete/digital input (contact status).
   2. Discrete/digital output.
   3. Analog input.
   4. Analog output.
   5. Pulse input (5 pulses/second).
   6. Pulse output (0-655 seconds in duration with 0.01 second resolution).

F. Monitor, control, or address data points. Mix shall include analog inputs, analog outputs, pulse
inputs, pulse outputs and discrete inputs/outputs, as required. Install control unit's with
minimum 30 percent spare capacity.

G. Point Scanning: Set scan or execution speed of each point to operator selected time from 1 to
250 seconds.

H. Upload/Download Capability: Download from or upload to operator station. Upload/Download
time for entire control unit database maximum 10 seconds on hard wired LAN, or 60 seconds
over voice grade phone lines.

I. Test Mode Operation: Place input/output points in test mode to allow testing and developing of
control algorithms on line without disrupting field hardware and controlled environment. In test
mode:
   1. Inhibit scanning and calculation of input points. Issue manual control to input points (set
analog or digital input point to operator determined test value) from work station.
   2. Control output points but change only data base state or value; leave external field
hardware unchanged.
   3. Enable control actions on output points but change only data base state or value.

J. Local display and adjustment panel: Portable control unit, containing digital display, and
numerical keyboard. Display and adjust:
   1. Input/output point information and status.
   2. Controller set points.
   3. Controller tuning constants.
   4. Program execution times.
   5. High and low limit values.
   7. Set/display date and time.
   8. Control outputs connected to the network.
10. Perform control unit diagnostic testing.
11. Points in "Test" mode.

2.07 LOCAL AREA NETWORK (LAN)

A. Provide communication between control units over local area network (LAN).
B. LAN Capacity: Not less than 100 stations or nodes.
C. Break in Communication Path: Alarm and automatically initiate LAN reconfiguration.
D. LAN Data Speed: Minimum 19.2 Kb.
E. Communication Techniques: Allow interface into network by multiple operation stations and by auto-answer/auto-dial modems. Support communication over telephone lines utilizing modems.
F. Transmission Median: Fiber optic or single pair of solid 24 gauge twisted, shielded copper cable.
G. Network Support: Time for global point to be received by any station, shall be less than 3 seconds. Provide automatic reconfiguration if any station is added or lost. If transmission cable is cut, reconfigure two sections with no disruption to system's operation, without operator intervention.

2.08 SYSTEM SOFTWARE

A. Operating System:
   1. Concurrent, multi-tasking capability.
   2. System Graphics:
      a. Allow up to 10 graphic screens, simultaneously displayed for comparison and monitoring of system status.
      b. Animation displayed by shifting image files based on object status.
      c. Provide method for operator with password to perform the following:
         1) Move between, change size, and change location of graphic displays.
         2) Modify on-line.
         3) Add, delete, or change dynamic objects consisting of:
            (a) Analog and binary values.
            (b) Dynamic text.
            (c) Static text.
            (d) Animation files.
   3. Custom Graphics Generation Package:
      a. Create, modify, and save graphic files and visio format graphics in PCX formats.
      b. HTML graphics to support web browser compatible formats.
      c. Capture or convert graphics from AutoCAD.
   4. Standard HVAC Graphics Library:
      a. HVAC Equipment:
      b. Ancillary Equipment:

B. Workstation System Applications:
   1. Automatic System Database Save and Restore Functions:
      a. Current database copy of each Building Controller is automatically stored on hard disk.
      b. Automatic update occurs upon change in any system panel.
In the event of database loss in any system panel, the first workstation to detect the loss automatically restores the database for that panel unless disabled by the operator.

2. Manual System Database Save and Restore Functions by Operator with Password Clearance:
   a. Save database from any system panel.
   b. Clear a panel database.
   c. Initiate a download of a specified database to any system panel.

3. Software provided allows system configuration and future changes or additions by operators under proper password protection.

4. On-line Help:
   a. Context-sensitive system assists operator in operation and editing.
   b. Available for all applications.
   c. Relevant screen data provided for particular screen display.
   d. Additional help available via hypertext.

5. Security:
   a. Operator log-on requires user name and password to view, edit, add, or delete data.
   b. System security selectable for each operator.
   c. System supervisor sets passwords and security levels for all other operators.
   d. Operator passwords to restrict functions accessible to viewing and/or changing system applications, editor, and object.
   e. Automatic, operator log-off results from keyboard or mouse inactivity during user-adjustable, time period.
   f. All system security data stored in encrypted format.

6. System Diagnostics:
   a. Operations Automatically Monitored:
      1) Workstations.
      2) Printers.
      3) Modems.
      4) Network connections.
      5) Building management panels.
      6) Controllers.
   b. Device failure is annunciated to the operator.

7. Alarm Processing:
   a. All system objects are configurable to "alarm in" and "alarm out" of normal state.
   b. Configurable Objects:
      1) Alarm limits.
      2) Alarm limit differentials.
      3) States.
      4) Reactions for each object.

8. Alarm Messages:
   b. Recognizable Features:
      1) Source.
      2) Location.
      3) Nature.

9. Configurable Alarm Reactions by Workstation and Time of Day:
   a. Logging.
   b. Printing.
   c. Starting programs.
   d. Displaying messages.
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- Dialing out to remote locations.
- Paging.
- Providing audible annunciation.
- Displaying specific system graphics.

10. Custom Trend Logs:
   - Definable for any data object in the system including interval, start time, and stop time.
   a. Trend Data:
      1) Sampled and stored on the building controller panel.
      2) Archivable on hard disk.
      3) retrievable for use in reports, spreadsheets and standard database programs.
      4) Archival on LAN accessible storage media including hard disk, tape, RAID array drive, and virtual cloud environment.
      5) Protected and encrypted format to prevent manipulation, or editing of historical data and event logs.

11. Alarm and Event Log:
   - View all system alarms and change of states from any system location.
   - Events listed chronologically.
   - Operator with proper security acknowledges and clears alarms.
   - Alarms not cleared by operator are archived to the workstation hard disk.

12. Object, Property Status and Control:
   - Provide a method to view, edit if applicable, the status of any object and property in the system.
   - Status Available by the Following Methods:
     1) Menu.
     2) Graphics.
     3) Custom Programs.

13. Reports and Logs:
   - Reporting Package:
     1) Allows operator to select, modify, or create reports.
     2) Definable as to data content, format, interval, and date.
     3) Archivable to hard disk.
   - Real-time logs available by type or status such as alarm, lockout, normal, etc.
   - Stored on hard disk and readily accessible by standard software applications, including spreadsheets and word processing.
   - Set to be printed on operator command or specific time(s).

14. Reports:
   - Standard:
     1) Objects with current values.
     2) Current alarms not locked out.
     3) Disabled and overridden objects, points and SNVTs.
     4) Objects in manual or automatic alarm lockout.
     5) Objects in alarm lockout currently in alarm.
   - Logs:
     (a) Alarm History.
     (b) System messages.
     (c) System events.
     (d) Trends.
   - Custom:
     1) Daily.
2) Weekly.
3) Monthly.
4) Annual.
5) Time and date stamped.
6) Title.
7) Facility name.
c. Tenant Override:
   1) Monthly report showing total, requested, after-hours HVAC and lighting services on a daily basis for each tenant.
   2) Annual report showing override usage on a monthly basis.
d. Electrical, Fuel, and Weather:
   1) Electrical Meter(s):
      (a) Monthly showing daily electrical consumption and peak electrical demand with time and date stamp for each meter.
      (b) Annual summary showing monthly electrical consumption and peak demand with time and date stamp for each meter.
   2) Fuel Meter(s):
      (a) Monthly showing daily natural gas consumption for each meter.
      (b) Annual summary showing monthly consumption for each meter.
   3) Weather:
      (a) Monthly showing minimum, maximum, average outdoor air temperature and heating/cooling degree-days for the month.
C. Workstation Applications Editors:
   1. Provide editing software for all system applications at the PC workstation.
   2. Downloaded application is executed at controller panel.
   3. Full screen editor for each application allows operator to view and change:
      a. Configuration.
      b. Name.
      c. Control parameters.
      d. Set-points.
   4. Scheduling:
      a. Monthly calendar indicates schedules, holidays, and exceptions.
      b. Allows several related objects to be scheduled and copied to other objects or dates.
      c. Start and stop times adjustable from master schedule.
   5. Custom Application Programming:
      a. Create, modify, debug, edit, compile, and download custom application programming during operation and without disruption of all other system applications.
      b. Programming Features:
         1) English oriented language, based on BASIC, FORTRAN, C, or PASCAL syntax allowing for free form programming.
         2) Alternative language graphically based using appropriate function blocks suitable for all required functions and amenable to customizing or compounding.
         3) Insert, add, modify, and delete custom programming code that incorporates word processing features such as cut/paste and find/replace.
         4) Allows the development of independently, executing, program modules designed to enable and disable other modules.
         5) Debugging/simulation capability that displays intermediate values and/or results including syntax/execution error messages.
6) Support for conditional statements (IF/THEN/ELSE/ELSE-F) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

7) Support for floating-point arithmetic utilizing plus, minus, divide, times, square root operators; including absolute value; minimum/maximum value from a list of values for mathematical functions.

8) Language consisting of resettable, predefined, variables representing time of day, day of the week, month of the year, date; and elapsed time in seconds, minutes, hours, and days where the variable values can be used in IF/THEN comparisons, calculations, programming statement logic, etc.

9) Language having predefined variables representing status and results of the system software enables, disables, and changes the set points of the controller software.

2.09 CONTROLLER SOFTWARE

A. All applications reside and operate in the system controllers and editing of all applications occurs at the operator workstation.

B. System Security:
   1. User access secured via user passwords and user names.
   2. Passwords restrict user to the objects, applications, and system functions as assigned by the system manager.
   3. User Log On/Log Off attempts are recorded.
   4. Automatic Log Off occurs following the last keystroke after a user defined delay time.

C. Object or Object Group Scheduling:
   1. Weekly Schedules Based on Separate, Daily Schedules:
      a. Include start, stop, optimal stop, and night economizer.
      b. 10 events maximum per schedule.
      c. Start/stop times adjustable for each group object.

D. Provide standard application for equipment coordination and grouping based on function and location to be used for scheduling and other applications.

E. Alarms:
   1. Binary object is set to alarm based on the operator specified state.
   2. Analog object to have high/low alarm limits.
   3. All alarming is capable of being automatically and manually disabled.
   4. Alarm Reporting:
      a. Operator determines action to be taken for alarm event.
      b. Alarms to be routed to appropriate workstation.
      c. Reporting Options:

F. Maintenance Management: System monitors equipment status and generates maintenance messages based upon user-designated run-time limits.

G. Sequencing: Application software based upon specified sequences of operation in Section 23 09 93.

H. PID Control Characteristics:
   1. Direct or reverse action.
   2. Anti-windup.
   3. Calculated, time-varying, analog value, positions an output or stages a series of outputs.

I. Staggered Start Application:
   1. Prevents all controlled equipment from simultaneously restarting after power outage.
2. Order of equipment startup is user selectable.

J. Energy Calculations:
1. Accumulated instantaneous power or flow rates are converted to energy use data.
2. Algorithm calculates a rolling average and allows window of time to be user specified in minute intervals.
3. Algorithm calculates a fixed window average with a digital input signal from a utility meter defining the start of the window period that in turn synchronizes the fixed-window average with that used by the power company.

K. Anti-Short Cycling:
1. All binary output objects protected from short-cycling.
2. Allows minimum on-time and off-time to be selected.

L. On-Off Control with Differential:
1. Algorithm allows binary output to be cycled based on a controlled variable and set-point.
2. Algorithm to be direct-acting or reverse-acting incorporating an adjustable differential.

M. Run-Time Totalization:
1. Totalize run-times for all binary input objects.
2. Provides operator with capability to assign high run-time alarm.

### 2.10 OPERATING SYSTEM SOFTWARE

A. Input/Output Capability From Operator Station:
1. Request display of current values or status in tabular or graphic format.
2. Command selected equipment to specified state.
3. Initiate logs and reports.
5. Add, delete, or change points within each control unit or application routine.
6. Change point input/output descriptors, status, alarm descriptors, and engineering unit descriptors.
7. Add new control units to system.
8. Modify and set up maintenance scheduling parameters.
9. Develop, modify, delete or display full range of color graphic displays.
10. Automatically archive select data even when running third party software.
11. Provide capability to sort and extract data from archived files and to generate custom reports.
12. Support two printer operations.
   a. Alarm printer: Print alarms, operator acknowledgements, action messages, system alarms, operator sign-on and sign-off.
   b. Data printer: Print reports, page prints, and data base prints.
13. Select daily, weekly or monthly as scheduled frequency to synchronize time and date in digital control units. Accommodate daylight savings time adjustments.
14. Print selected control unit data base.

B. Operator System Access: Via software password with minimum 30 access levels at work station and minimum 3 access levels at each control unit.

C. Data Base Creation and Support: Changes shall utilize standard procedures. Control unit shall automatically check work station data base files upon connection and verify data base match. Minimum capability shall include:
1. Add and delete points.
2. Modify any point parameter.
3. Change, add, or delete English language descriptors.
4. Add, modify, or delete alarm limits.
5. Add, modify, or delete points in start/stop programs, trend logs, etc.
6. Create custom relationship between points.
7. Create or modify DDC loops and parameters.
8. Create or modify override parameters.
9. Add, modify, and delete any applications program.
10. Add, delete, develop, or modify dynamic color graphic displays.

D. Dynamic Color Graphic Displays:
1. Utilizes custom symbols or system supported library of symbols.
2. Sixteen (16) colors.
3. Sixty (60) outputs of real time, live dynamic data per graphic.
4. Dynamic graphic data.
5. 1,000 separate graphic pages.
6. Modify graphic screen refresh rate between 1 and 60 seconds.

E. Operator Station:
1. Accept data from LAN as needed without scanning entire network for updated point data.
2. Interrogate LAN for updated point data when requested.
3. Allow operator command of devices.
4. Allow operator to place specific control units in or out of service.
5. Allow parameter editing of control units.
6. Store duplicate data base for every control unit and allow down loading while system is on line.
7. Control or modify specific programs.
8. Develop, store and modify dynamic color graphics.
9. Provide data archiving of assigned points and support overlay graphing of this data utilizing up to four (4) variables.

F. Alarm Processing:
1. Off normal condition: Cause alarm and appropriate message, including time, system, point descriptor, and alarm condition. Select alarm state/value and which alarms shall cause automatic dial-out.
2. Critical alarm or change-of-state: Display message, stored on disk for review and sort, or print.
3. Print on line changeable message, up to 100 characters in length, for each alarm point specified.
4. Display alarm reports on video. Display multiple alarms in order of occurrence.
5. Define time delay for equipment start-up or shutdown.
6. Allow unique routing of specific alarms.
7. Operator specifies if alarm requires acknowledgement.
8. Continue to indicate unacknowledged alarms after return to normal.
9. Alarm notification:
   a. Automatic print.
   b. Display indicating alarm condition.
   c. Selectable audible alarm indication.

G. Event Processing: Automatically initiate commands, user defined messages, take specific control actions or change control strategy and application programs resulting from event condition. Event condition may be value crossing operator defined limit, change-of-state, specified state, or alarm occurrence or return to normal.

H. Automatic Restart: Automatically restart field equipment on restoration of power. Provide time delay between individual equipment restart and time of day start/stop.

I. Messages:
1. Automatically display or print user-defined message subsequent to occurrence of selected events.
2. Compose, change, or delete any message.
3. Display or log any message at any time.
4. Assign any message to any event.

J. Reports:
1. Manually requested with time and date.
2. Long term data archiving to hard disk.
3. Automatic directives to download to transportable media such as floppy diskettes for storage.
4. Data selection methods to include data base search and manipulation.
5. Data extraction with mathematical manipulation.
6. Data reports shall allow development of XY curve plotting, tabular reports (both statistical and summary), and multi-point timed based plots with not less than four (4) variables displayed.
7. Generating reports either normally at operator direction, or automatically under work station direction.
8. Reports may either manually displayed or printed, or may be printed automatically on daily, weekly, monthly, yearly or scheduled basis.
9. Include capability for statistical data manipulation and extraction.
10. Provide capability to generate four types of reports: Statistical detail reports, summary reports, trend graphic plots, x-y graphic plots.

K. Parameter Save/Restore: Store most current operating system, parameter changes, and modifications on disk or diskette.

L. Data Collection:
1. Automatically collect and store in disk files.
2. Daily electrical energy consumption, peak demand, and time of peak demand for up to electrical meters over 2 year period.
3. Daily consumption for up to 30 meters over a 2 year period.
4. Daily billable electrical energy consumption and time for up to 1024 zones over a 10 year period.
5. Provide archiving of stored data for use with system supplied custom reports.

M. Graphic Display: Support graphic development on work station with software features:
1. Page linking.
2. Generate, store, and retrieve library symbols.
3. Single or double height characters.
4. Sixty (60) dynamic points of data per graphic page.
5. Pixel level resolution.
6. Animated graphics for discrete points.
7. Analog bar graphs.
8. Display real time value of each input or output line diagram fashion.

N. Maintenance Management:
1. Run time monitoring, per point.
2. Maintenance scheduling targets with automatic annunciation, scheduling and shutdown.
3. Equipment safety targets.
4. Display of maintenance material and estimated labor.
5. Target point reset, per point.

O. Advisories:
1. Summary which contains status of points in locked out condition.
2. Continuous operational or not operational report of interrogation of system hardware and programmable control units for failure.
3. Report of power failure detection, time and date.
4. Report of communication failure with operator device, field interface unit, point, programmable control unit.

2.11 LOAD CONTROL PROGRAMS

A. General: Support inch-pounds and SI (metric) units of measurement.

B. Demand Limiting:
1. Monitor total power consumption per power meter and shed associated loads automatically to reduce power consumption to an operator set maximum demand level.
2. Input: Pulse count from incoming power meter connected to pulse accumulator in control unit.
4. Automatically shed loads throughout the demand interval selecting loads with independently adjustable on and off time of between one and 255 minutes.
5. Demand Target: Minimum of 3 per demand meter; change targets based upon (1) time, (2) status of pre-selected points, or (3) temperature.
6. Load: Assign load shed priority, minimum "ON" time and maximum "OFF" time.
7. Limits: Include control band (upper and lower limits).
8. Output advisory if loads are not available to satisfy required shed amount, advise shed requirements and requiring operator acknowledgement.

C. Duty Cycling:
1. Periodically stop and start loads, based on space temperature, and according to various On/Off patterns.
2. Modify off portion of cycle based on operator specified comfort parameters. Maintain total cycle time by increasing on portion of cycle by same amount that off portion is reduced.
3. Set and modify following parameters for each individual load.
   a. Minimum and maximum Off time.
   b. On/Off time in one minute increments.
   c. Time period from beginning of interval until load can be cycled.
   d. Manually override the DCC program and place a load in an On or Off state.
   e. Cooling Target Temperature and Differential.
   f. Heating Target Temperature and Differential.
   g. Cycle off adjustment.

D. Automatic Time Scheduling:
2. Support up to seven (7) normal day schedules, seven (7) "special day" schedules and two (2) temporary day schedules.
3. Special days schedule shall support up to 30 unique date/duration combinations.
4. Any number of loads assigned to any time program; each load can have individual time program.
5. Each load assigned at least 16 control actions per day with 1 minute resolution.
6. Time schedule operations may be:
   a. Start.
   b. Optimized Start.
   c. Stop.
   d. Optimized Stop.
   e. Cycle.
   f. Optimized Cycle.
7. Minimum of 30 holiday periods up to 100 days in length may be specified for the year.
8. Create temporary schedules.
9. Broadcast temporary "special day" date and duration.

E. Start/Stop Time Optimization:
1. Perform optimized start/stop as function of outside conditions, inside conditions, or both.
2. Adaptive and self-tuning, adjusting to changing conditions unattended.
3. For each point under control, establish and modify:
   a. Occupancy period.
   b. Desired temperature at beginning of occupancy period.
   c. Desired temperature at end of occupancy period.

F. Night Setback/Setup Program: Reduce heating space temperature setpoint or raise cooling space temperature setpoint during unoccupied hours; in conjunction with scheduled start/stop and optimum start/stop programs.

G. Calculated Points: Define calculations and totalization computed from monitored points (analog/digital points), constants, or other calculated points.
1. Employ arithmetic, algebraic, Boolean, and special function operations.
2. Treat calculated values like any other analog value, use for any function that a "hard wired point" might be used.

H. Event Initiated Programming: Event may be initiated by any data point, causing series of controls in a sequence.
1. Define time interval between each control action between 0 to 3600 seconds.
2. Output may be analog value.
3. Provide for "skip" logic.
4. Verify completion of one action before proceeding to next. If not verified, program shall be able to skip to next action.

I. Direct Digital Control: Each control unit shall provide Direct Digital Control software so that the operator may customize control strategies and sequences of operation by defining the appropriate control loop algorithms and choosing the optimum loop parameters.
1. Control loops: Defined using "modules" that are analogous to standard control devices.
2. Output: Paired or individual digital outputs for pulse-width modulation, and analog outputs, as required.
3. Firmware:
   a. PID with analog or pulse-width modulation output.
   b. Floating control with pulse-width modulated outputs.
   c. Two-position control.
   d. Primary and secondary reset schedule selector.
   e. Hi/Lo signal selector.
   f. Single pole double throw relay.
   g. Single pole double throw time delay relay with delay before break, delay before make, and interval time capabilities.
4. Direct Digital Control loops: Downloaded upon creation or on operator request. On sensor failure, program shall execute user defined failsafe output.
5. Display: Value or state of each of the lines which interconnect DDC modules.

J. Fine Tuning Direct Digital Control PID or floating loops:
1. Display information:
   a. Control loop being tuned
   b. Input (process) variable
   c. Output (control) variable
   d. Setpoint of loop
e. Proportional band  
f. Integral (reset) Interval  
g. Derivative (rate) Interval

2. Display format: Graphic, with automatic scaling; with input and output variable superimposed on graph of “time” vs “variable”.

K. Trend logging:
1. Each control unit will store samples of control unit’s data points. 
2. Update file continuously at discretely assignable intervals. 
3. Automatically initiate upload request and then store data on hard disk. 
4. Time synchronize sampling at operator specified times and intervals with sample resolution of one minute. 
5. Co-ordinate sampling with on/off state of specified point. 
6. Display trend samples on work station in graphic format. Automatically scale trend graph with minimum 60 samples of data in plot of time vs data.

2.12 HVAC CONTROL PROGRAMS

A. General: 
1. Support Inch-pounds and SI (metric) units of measurement. 
2. Identify each HVAC Control system.

B. Optimal Run Time: 
1. Control start-up and shutdown times of HVAC equipment for both heating and cooling. 
2. Base on occupancy schedules, outside air temperature, seasonal requirements, and interior room mass temperature. 
3. Start-up systems by using outside air temperature, room mass temperatures, and adaptive model prediction for how long building takes to warm up or cool down under different conditions. 
4. Use outside air temperature to determine early shut down with ventilation override. 
5. Analyze multiple building mass sensors to determine seasonal mode and worse case condition for each day. 
6. Operator commands: 
   a. Define term schedule 
   b. Add/delete fan status point. 
   c. Add/delete outside air temperature point. 
   d. Add/delete mass temperature point. 
   e. Define heating/cooling parameters. 
   f. Define mass sensor heating/cooling parameters. 
   g. Lock/unlock program. 
   h. Request optimal run time control summary. 
   i. Request optimal run time mass temperature summary. 
   j. Request HVAC point summary. 
   k. Request HVAC saving profile summary. 
7. Control Summary: 
   a. HVAC Control system begin/end status. 
   b. Optimal run time lock/unlock control status. 
   c. Heating/cooling mode status. 
   d. Optimal run time schedule. 
   e. Start/Stop times. 
   f. Selected mass temperature point ID. 
   g. Optimal run time system normal start times. 
   h. Occupancy and vacancy times.
i. Optimal run time system heating/cooling mode parameters.

8. Mass temperature summary:
   a. Mass temperature point type and ID.
   b. Desired and current mass temperature values.
   c. Calculated warm-up/cool-down time for each mass temperature.
   d. Heating/cooling season limits.
   e. Break point temperature for cooling mode analysis.

9. HVAC point summary:
   a. Control system identifier and status.
   b. Point ID and status.
   c. Outside air temperature point ID and status.
   d. Mass temperature point ID and point.
   e. Calculated optimal start and stop times.
   f. Period start.

C. Supply Air Reset:
   1. Monitor heating and cooling loads in building spaces, terminal reheat systems, both hot
      deck and cold deck temperatures on dual duct and multizone systems, single zone unit
      discharge temperatures.
   2. Adjust discharge temperatures to most energy efficient levels satisfying measured load
      by:
      a. Raising cooling temperatures to highest possible value.
      b. Reducing heating temperatures to lowest possible level.
   3. Operator commands:
      a. Add/delete fan status point.
      b. Lock/unlock program.
      c. Request HVAC point summary.
      d. Add/Delete discharge controller point.
      e. Define discharge controller parameters.
      f. Add/delete air flow rate.
      g. Define space load and load parameters.
      h. Request space load summary.
   4. Control summary:
      a. HVAC control system status (begin/end).
      b. Supply air reset system status.
      c. Optimal run time system status.
      d. Heating and cooling loop.
      e. High/low limits.
      f. Deadband.
      g. Response timer.
      h. Reset times.
   5. Space load summary:
      a. HVAC system status.
      b. Optimal run time status.
      c. Heating/cooling loop status.
      d. Space load point ID.
      e. Current space load point value.
      f. Control heat/cool limited.
      g. Gain factor.
      h. Calculated reset values.
      i. Fan status point ID and status.
j. Control discharge temperature point ID and status.
k. Space load point ID and status.
l. Air flow rate point ID and status.

D. Enthalpy Switchover:
   1. Calculate outside and return air enthalpy using measured temperature and relative humidity; determine energy expended and control outside and return air dampers.
   2. Operator commands:
      a. Add/delete fan status point.
      b. Add/delete outside air temperature point.
      c. Add/delete discharge controller point.
      d. Define discharge controller parameters.
      e. Add/delete return air temperature point.
      f. Add/delete outside air dew point/humidity point.
      g. Add/delete return air dew point/humidity point.
      h. Add/delete damper switch.
      i. Add/delete minimum outside air.
      j. Add/delete atmospheric pressure.
      k. Add/delete heating override switch.
      l. Add/delete evaporative cooling switch.
      m. Add/delete air flow rate.
      n. Define enthalpy deadband.
      o. Lock/unlock program.
      p. Request control summary.
      q. Request HVAC point summary.

3. Control summary:
   a. HVAC control system begin/end status.
   b. Enthalpy switchover optimal system status.
   c. Optimal return time system status.
   d. Current outside air enthalpy.
   e. Calculated mixed air enthalpy.
   f. Calculated cooling cool enthalpy using outside air.
   g. Calculated cooling cool enthalpy using mixed air.
   h. Calculated enthalpy difference.
   i. Enthalpy switchover deadband.
   j. Status of damper mode switch.

2.13 PROGRAMMING APPLICATION FEATURES

A. Trend Point:
   1. Sample up to 150 points, real or computed, with each point capable of collecting 100 samples at intervals specified in minutes, hours, days, or month.
   2. Output trend logs as line graphs or bar graphs. Output graphic on terminal, with each point for line and bar graphs designated with a unique pattern, vertical scale either actual values or percent of range, and horizontal scale time base. Print trend logs up to 12 columns of one point/column.

B. Alarm Messages:
   1. Allow definition of minimum of 100 messages, each having minimum length of 100 characters for each individual message.
   2. Assign alarm messages to system messages including point's alarm condition, point's off-normal condition, totalized point's warning limit, hardware elements advisories.
   3. Output assigned alarm with "message requiring acknowledgement".
4. Operator commands include define, modify, or delete; output summary listing current alarms and assignments; output summary defining assigned points.

C. Weekly Scheduling:
1. Automatically initiate equipment or system commands, based on preselected time schedule for points specified.
2. Provide program times for each day of week, per point, with one minute resolution.
3. Automatically generate alarm output for points not responding to command.
4. Provide for holidays, minimum of 366 consecutive holidays.
5. Operator commands:
   a. System logs and summaries.
   b. Start of stop point.
   c. Lock or unlock control or alarm input.
   d. Add, delete, or modify analog limits and differentials.
   e. Adjust point operation position.
   f. Change point operational mode.
   g. Open or close point.
   h. Enable/disable, lock/unlock, or execute interlock sequence or computation profile.
   i. Begin or end point totalization.
   j. Modify totalization values and limits.
   k. Access or secure point.
   l. Begin or end HVAC or load control system.
   m. Modify load parameter.
   n. Modify demand limiting and duty cycle targets.
6. Output summary: Listing of programmed function points, associated program times, and respective day of week programmed points by software groups or time of day.

D. Interlocking:
1. Permit events to occur, based on changing condition of one or more associated master points.
2. Binary contact, high/low limit of analog point or computed point shall be capable of being utilized as master. Same master may monitor or command multiple slaves.
3. Operator commands:
   a. Define single master/multiple master interlock process.
   b. Define logic interlock process.
   c. Lock/unlock program.
   d. Enable/disable interlock process.
   e. Execute terminate interlock process.
   f. Request interlock type summary.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify existing conditions before starting work.
B. Verify that conditioned power supply is available to the control units and to the operator work station. Verify that field end devices, wiring, and pneumatic tubing is installed prior to installation proceeding.

3.02 INSTALLATION
A. Install all Owner-provided equipment along with all contractor-provided equipment as required to provide a complete, fully functional building automation system.
B. Install control units and other hardware in position on permanent walls where not subject to excessive vibration.
C. Install software in control units and in operator work station. Implement all features of programs to specified requirements and appropriate to sequence of operation. Refer to Section 23 09 93.

D. Provide with 120v AC, 15 amp dedicated emergency power circuit to each programmable control unit.

E. Provide conduit and electrical wiring in accordance with Section 26 27 17. Electrical material and installation shall be in accordance with appropriate requirements of.

F. Ensure that all components necessary to execute the sequences of operation are coordinated and installed by all contractors.

3.03 MANUFACTURER’S FIELD SERVICES

A. Start and commission systems. Allow sufficient time for start-up and commissioning prior to placing control systems in permanent operation.

B. Provide service engineer to instruct Owner’s representative in operation of systems plant and equipment for 2 day period.

C. Provide basic operator training for 4 persons on data display, alarm and status descriptors, requesting data, execution of commands and request of logs. Include a minimum of 8 hours dedicated instructor time. Provide training on site.

3.04 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate complete and operating system to Owner.

3.05 SCHEDULES

A. Input/Output Schedule:
   1. Point Description:
   2. Digital Input:
      a. Demand Meter (kW):
      b. Auxiliary Contact:
      c. Switches:
         1) Switch Closing:
         2) Flow Switch:
         3) Optical:
      d. Current:
      e. Pressure:
   3. Digital Output:
      a. Control Relay:
      b. Solenoid:
      c. Contactor:
   4. Analog Input:
      a. Temperature:
      b. Relative Humidity:
      c. Pressure/Vacuum:
      d. Filter:
      e. Flow:
      f. Current:
      g. Liquid Level:
      h. Photocell:
   5. Analog Output:
      a. Pneumatic Transducer:
      b. 4-20 ma Module:
c. 0-16 v DC:

6. Alarm:

B. Input/Output Schedule:
   1. Point Description:
      2. Inputs:
         a. Temperature:
         b. Relative Humidity:
         c. Pressure:
         d. Flow:
         e. Level:
         f. Position:
         g. Energy:
         h. Power:
   3. Outputs:
      a. Status:
      b. Alarm:
      c. Pneumatic Position:
      d. Electronic Position:
      e. Set Point Adjust:
      f. Start/Stop:
      g. Off/Low/High:
   4. Software Features:
      a. PID Control (DDC):
      b. High Limit:
      c. Low Limit:
      d. Run Time Totalization:
      e. Consumption Totalization:
      f. Program Start/Stop:
      g. Load Shed:
      h. Duty Cycle:
      i. Enthalpy Switchover:
      j. Optimal Run Time:
      k. Supply Air Reset:
      l. O.A. Interlock:
      m. O.A. Temperature Reset:
      n. Free Cooling Mode:
      o. Warm-up Mode:
      p. Boiler Interlock:
      q. Chiller Sequencing:
      r. Energy Calculation:

C. Alarm Schedule:

END OF SECTION
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

THE MECHANICAL CONTRACTOR SHALL PROVIDE ALL NECESSARY LABOR AND MATERIALS TO PROVIDE A FULLY FUNCTIONAL BUILDING AUTOMATION SYSTEM FOR THE PROJECT. THIS INCLUDES ALL CONTROL COMPONENTS, CONTROLLERS, WIRING, PROGRAMMING, AND COORDINATION BETWEEN TRADES TO ACCOMPLISH THE SEQUENCE OF OPERATIONS HEREIN. CONTRACTOR SHALL ENSURE THAT ALL COMPONENTS ARE COORDINATED BETWEEN EQUIPMENT SUPPLIERS AND CONTROLS VENDOR FOR ALL EQUIPMENT.

1.01 PART 1 GENERAL

1.02 SECTION INCLUDES

A. This section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other sections.

B. Sequence of operation for:
   1. Air terminal units.
   2. Variable Refrigerant Volume (VRF/VRV) Systems
   3. Supply Air Units and Energy recovery
   4. Split System Heat Pumps / Cooling Units

1.03 RELATED SECTIONS

A. Section 23 09 23 - Direct-Digital Control System for HVAC.
B. Section 23 09 13 - Instrumentation and Control Devices for HVAC.
C. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.04 SYSTEM DESCRIPTION

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation are specified. Equipment, devices, and system components required for control systems are specified in other Sections.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Sequence of Operation Documentation: Submit written sequence of operation for entire HVAC system and each piece of equipment.
   1. Preface: 1 or 2 paragraph overview narrative of the system describing its purpose, components and function.
   2. State each sequence in small segments and give each segment a unique number for referencing in Functional Test procedures; provide a complete description regardless of the completeness and clarity of the sequences specified in the contract documents.
   3. Include at least the following sequences:
      a. Start-up.
      b. Warm-up mode.
      c. Normal operating mode.
      d. Unoccupied mode.
      e. Shutdown.
      f. Capacity control sequences and equipment staging.
      g. Temperature and pressure control, such as setbacks, setups, resets, etc.
      h. Detailed sequences for all control strategies, such as economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
      i. Effects of power or equipment failure with all standby component functions.
j. Sequences for all alarms and emergency shut downs.
k. Seasonal operational differences and recommendations.
l. Interactions and interlocks with other systems.

4. Include initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff, and any other control settings or fixed values, delays, etc. that will be useful during testing and operating the equipment.

5. For packaged controlled equipment, include manufacturer’s furnished sequence of operation amplified as required to describe the relationship between the packaged controls and the control system, indicating which points are adjustable control points and which points are only monitored.

6. Include schedules, if known.

C. Control System Diagrams: Submit graphic schematic of the control system showing each control component and each component controlled, monitored, or enabled.
   1. Label with settings, adjustable range of control and limits.
   2. Include flow diagrams for each control system, graphically depicting control logic.
   3. Include the system and component layout of all equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
   4. Include draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
   5. Include all monitoring, control and virtual points specified in elsewhere.
   6. Include a key to all abbreviations.

D. Points List: Submit list of all control points indicating at least the following for each point.
   1. Name of controlled system.
   2. Point abbreviation.
   3. Point description; such as dry bulb temperature, airflow, etc.
   4. Display unit.
   5. Control point or setpoint (Yes / No); i.e. a point that controls equipment and can have its setpoint changed.
   6. Monitoring point (Yes / No); i.e. a point that does not control or contribute to the control of equipment but is used for operation, maintenance, or performance verification.
   7. Intermediate point (Yes / No); i.e. a point whose value is used to make a calculation which then controls equipment, such as space temperatures that are averaged to a virtual point to control reset.
   8. Calculated point (Yes / No); i.e. a “virtual” point generated from calculations of other point values.

E. Project Record Documents: Record actual locations of components and setpoints of controls, including changes to sequences made after submission of shop drawings.

1.06 QUALITY ASSURANCE
   A. Design system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State in which the Project is located.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL SYSTEM DESIGN AND OPERATION STANDARDS
   A. Each unit shall be controlled by an individual DDC Controller and all required sensors, control valves, and appurtenances required to complete the sequence of operation. Units shall include
occupied/unoccupied control, night-setback, morning warm-up/cool-down, and enthalpy-based economizer functions.

3.02 SPLIT SYSTEM HEAT PUMP SYSTEMS

A. The split system shall have a BAS DDC controller for temperature control and monitoring of the system.

B. Sequence of operation:

1. Cooling Mode: Cooling mode shall be selected based on outdoor air temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously with any associated outdoor air dampers open. On a rise in space temperature above the setpoint (75 degrees, adjustable), the manufacturer controller shall energize the central compressor to provide cooling. The internal capacity control valve in the evaporator unit shall modulate to control the flow of refrigerant to maintain space temperature. On a fall in space temperature the refrigerant capacity control valve shall modulate closed.

2. Heating Mode: Heating mode shall be selected based on outdoor air temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously with any associated outside air damper open to the minimum position. On a drop in space temperature below the setpoint (70 degrees, adjustable), the manufacturer central controller shall energize the central compressor to with the requisite reversing valve to provide heating to the evaporator unit as required. The internal capacity control valve in the evaporator unit shall modulate to control the flow of refrigerant to maintain space temperature. On a fall in space temperature the refrigerant capacity control valve shall modulate closed.

3. The following items shall be accessible and displayed at the Operator's Terminal:
   a. Commanded status of associated outdoor air damper.
   b. Space temperature setpoint at each fan-coil unit (user adjustable).
   c. Actual space temperature of each fan-coil unit.
   d. Operational status of each fan-coil unit (heating, cooling, off, user adjustable).
   e. Remote space temperature sensor override for each fan-coil unit (user adjustable to limit temperature adjustment range, heat/cool selection, fan speed).
   f. Compressor Status

3.03 AIR TERMINAL UNITS

A. Single-duct Variable Volume:

1. Cooling with Reheat:
   a. The VAV terminal unit shall modulate the supply air damper as required to maintain space temperature cooling setpoint (76 degrees, adjustable).
   b. As the space temperature continues to fall to the heating set-point (70 degrees, adjustable), the terminal modulates to its heating minimum airflow. At this point, the heat will be staged on as follows:
      1) Hot water coil shall modulate as required to maintain space temperature heating setpoint.
   c. The following items shall be displayed at the Operator's Terminal:
      1) Space temperature for each VAV unit.
      2) Space temperature setpoint for each VAV unit.
      3) Damper position (commanded)
      4) Control valve position (commanded)
      5) High space temperature alarm
      6) Low space temperature alarm.
3.04 VARIABLE REFRIGERANT VOLUME HEAT PUMP SYSTEMS

A. The variable refrigerant split system shall have a BAS DDC interface wired to the manufacturer factory central system controller to provide operation, configuration, and monitoring of the system. The manufacturer factory central controller shall operate in BACnet protocol, and be connected to manufacturer factory space temperature sensors as specified.

B. Sequence of operation:
   1. Cooling Mode: Cooling mode shall be selected based on outdoor air temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously. On a rise in space temperature above the setpoint (75 degrees, adjustable), the manufacturer central controller shall energize the central compressor to provide cooling. The internal capacity control valve in the evaporator unit shall modulate to control the flow of refrigerant to maintain space temperature. On a fall in space temperature the refrigerant capacity control valve shall modulate closed.
   2. Heating Mode: Heating mode shall be selected based on outdoor air temperatures or manually enabled or scheduled from the workstation. During the programmed occupied mode, the supply fan shall run continuously. On a drop in space temperature below the setpoint (68 degrees, adjustable), the manufacturer central controller shall energize the central compressor to with the requisite reversing valve to provide heating to the evaporator unit as required. The internal capacity control valve in the evaporator unit shall modulate to control the flow of refrigerant to maintain space temperature. On a fall in space temperature the refrigerant capacity control valve shall modulate closed.
   3. The following items shall be accessible and displayed at the Operator’s Terminal:
      a. Space temperature setpoint at each fan-coil unit (user adjustable).
      b. Actual space temperature of each fan-coil unit space.
      c. Operational status of each fan-coil unit (heating, cooling, off, user adjustable).
      d. Factory error codes from each unit.
      e. Remote space temperature sensor override for each fan-coil unit (user adjustable to limit temperature adjustment range, heat/cool selection, fan speed).
      f. Compressor Status

C. Each terminal unit (fan coil) shall be controlled by the factory-provided wall-mounted controller. The controller shall be capable of allowing space temperature adjustment of +1 / -1 degrees (user adjustable).

D. Where multiple units serve the same zone, a factory-supplied control twinning kit will be provided to allow for a single temperature sensor to control both zones.

E. For all public corridors, restrooms, and vestibules, provide stainless-steel flat-plate type temperature sensors with no setpoint adjustment.

3.05 ENERGY RECOVERY VENTILATORS (ERV) FOR VRF SYSTEMS

A. Supply air units and ERV’s shall be scheduled for occupied and unoccupied cycles based on an operator adjustable time schedule. Units may also be manually enabled and disabled at the operator workstation. Fan status shall be monitored by the BAS via the fans current sensing relay.

B. The variable frequency drives shall be set by the balancer to deliver the minimum outdoor air to each associated terminal unit under fully-occupied conditions.

C. When any heat pump in the area served be the heat recovery unit is in the occupied mode the unit shall be energized.
   1. The unit exhaust and outside air isolation dampers shall open.
   2. Provide proof of airflow for each fan and provide fan failure alarms.
3. Provide temperature indication of the supply and exhaust inlet and leaving air.
4. For units over 2,000 cfm a duct smoke detector shall be provided by the electrical contractor. Provide the interlock wiring to shut down the units upon activation.
5. The electric heating coil shall be energized when required to maintain a minimum discharge air (supply air) temperature of 72 degrees (adjustable) to the units.

D. The following items shall be displayed at the operators workstation:
   1. Discharge temperature.
   2. Return air temperature.
   3. Outside air temperature, humidity and enthalpy.
   4. Fan operational status via current sensor.
   5. Commanded status of fan.
   6. Commanded status of heating coils (as applicable).
   7. Commanded position of dampers.
   8. Diagram showing the layout of the unit with major components and dynamic temperatures shown where temperature sensors exist in the system.

END OF SECTION
SECTION 23 21 13
HYDRONIC PIPING

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Hydronic system requirements (Chilled water, hot water, dual temperature)
B. Heating water piping, above grade.
C. Equipment Drains and Overflows

1.02  RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 08 31 00 - Access Doors and Panels.
C. Section 09 90 00 - Painting and Coating.
D. Section 22 05 48 - Vibration and Seismic Controls for Plumbing Piping and Equipment.
E. Section 22 05 53 - Identification for Plumbing Piping and Equipment.
F. Section 22 07 19 - Plumbing Piping Insulation.
G. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.
H. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
I. Section 23 05 48 - Vibration and Seismic Control for HVAC and Plumb, Piping and Equip..
J. Section 23 05 53 - Identification for HVAC Piping and Equipment.
K. Section 23 07 19 - HVAC Piping Insulation.
L. Section 23 21 14 - Hydronic Specialties.
M. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.
N. Section 26 27 17 - Equipment Wiring: Electrical characteristics and wiring connections.

1.03  REFERENCE STANDARDS
A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300.
C. ASME B16.3 - Malleable Iron Threaded Fittings; The American Society of Mechanical Engineers.
D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
E. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
F. ASME B31.9 - Building Services Piping.
G. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers.
H. ASME B31.5 - Refrigeration Piping and Heat Transfer Components; The American Society of Mechanical Engineers.
I. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers (ANSI/ASME B31.9).


O. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.


R. ASTM D2310 - Standard Classification for Machine-Made "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe.


W. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.


Z. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.


AB. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society.

AC. AWS D1.1/D1.1M - Structural Welding Code - Steel.

AD. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems; American Water Works Association (ANSI/AWWA C105/A21.5).


AF. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast.


1.04 SYSTEM DESCRIPTION

A. 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.
B. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.

1.05 SUBMITTALS
A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
B. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
B. Installer Qualifications: Company specializing in performing work of the type specified in this section, with minimum three years of experience.

1.07 REGULATORY REQUIREMENTS
A. Conform to ASME B31.9 code for installation of piping system.

1.08 DELIVERY, STORAGE, AND HANDLING
A. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
B. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.09 FIELD CONDITIONS
A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 DUAL TEMPERATURE OR HEATING WATER PIPING, ABOVE GROUND
A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
   4. Joints: Threaded, or AWS D1.1 welded.

B. Steel Pipe Sizes 12 Inch and Over: ASTM A53/A53M, 0.375 inch wall, black, using one of the following joint types:
   2. Joints: Welded in accordance with AWS D1.1.

C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
      a. Solder: ASTM B32 lead-free solders, HB alloy (95-5 tin-antimony) or tin and silver.
      b. Brazed: AWS A5.8M/A5.8 BCuP copper/silver alloy.
   2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
   3. Joints: Solder, lead free, 95-5 tin-antimony, or tin and silver.
2.02 EQUIPMENT DRAINS AND OVERFLOWS

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
   1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
   2. Joints: Solder, lead free, ASTM B 32, HB alloy (95-5 tin-antimony), or tin and silver.

B. PVC Pipe: ASTM D1785, Schedule 40, or ASTM D2241, SDR 21 or 26.
   1. Fittings: ASTM D2466 or D2467, PVC.
   2. Joints: Solvent welded in accordance with ASTM D2855.

2.03 PIPE HANGERS AND SUPPORTS

A. Provide hangers and supports that comply with MSS SP-58.
   1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.

B. Conform to ASME B31.9.

C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.

D. Hangers for Cold Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.

E. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.

F. Hangers for Hot Pipe Sizes 6 Inches and Over: Adjustable steel yoke, cast iron roll, double hanger.

G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

H. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.

I. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.

J. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel clamp.

K. Wall Support for Hot Pipe Sizes 6 Inches and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.

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: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

O. Floor Support for Hot Pipe Sizes 6 Inches and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.

P. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

Q. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

R. Inserts: Malleable iron case of 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.

S. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
PART 3 EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
B. Remove scale and dirt on inside and outside before assembly.
C. Prepare piping connections to equipment using jointing system specified.
D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.02 INSTALLATION

A. All condensate installed above inaccessible ceilings, behind walls, or exterior to building shall be provided as copper.
B. Install in accordance with manufacturer’s instructions.
C. Install heating water, chilled water, dual-temperature, and condenser water piping to ASME B31.9 requirements.
D. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.
E. Route piping in orderly manner, parallel to building structure, and maintain gradient.
F. Install piping to conserve building space and to avoid interfere with use of space.
G. Group piping whenever practical at common elevations.
H. Sleeve pipe passing through partitions, walls and floors.
I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
J. Slope piping and arrange to drain at low points.
K. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
   1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
L. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
M. Pipe Hangers and Supports:
   1. Install in accordance with ASME B31.9.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
8. Provide copper plated hangers and supports for copper piping.
9. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

N. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 19.
O. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
P. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08 31 00.
Q. Use eccentric reducers to maintain top of pipe level.
R. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
S. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Section 09 90 00.
T. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES
A. Hanger Spacing for Copper Tubing.
1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.
4. 2-1/2 inch: Maximum span, 9 feet; minimum rod size, 3/8 inch.
5. 3 inch: Maximum span, 10 feet; minimum rod size, 3/8 inch.
6. 4 inch: Maximum span, 12 feet; minimum rod size, 1/2 inch.
7. 6 inch: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 8 inch: Maximum span, 16 feet; minimum rod size, 5/8 inch.
9. 10 inch: Maximum span, 18 feet; minimum rod size, 3/4 inch.
10. 12 inch: Maximum span, 19 feet; minimum rod size, 7/8 inch.

B. Hanger Spacing for Steel Piping.
1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 1/4 inch.
2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
7. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
8. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
9. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
10. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
11. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.
12. 14 inches: Maximum span, 25 feet; minimum rod size, 1 inch.
13. 16 inches: Maximum span, 27 feet; minimum rod size, 1 inch.
14. 18 inches: Maximum span, 28 feet; minimum rod size, 1-1/4 inch.
15. 20 inches: Maximum span, 30 feet; minimum rod size, 1-1/4 inch.

C. Hanger Spacing for Plastic Piping.
1. 1/2 inch: Maximum span, 42 inches; minimum rod size, 1/4 inch.
2. 3/4 inch: Maximum span, 45 inches; minimum rod size, 1/4 inch.
3. 1 inch: Maximum span, 51 inches; minimum rod size, 1/4 inch.
4. 1-1/4 inches: Maximum span, 57 inches; minimum rod size, 3/8 inch.
5. 1-1/2 inches: Maximum span, 63 inches; minimum rod size, 3/8 inch.
6. 2 inches: Maximum span, 69 inches; minimum rod size, 3/8 inch.
7. 3 inches: Maximum span, 7 feet; minimum rod size, 3/8 inch.
8. 4 inches: Maximum span, 8 feet; minimum rod size, 1/2 inch.
9. 6 inches: Maximum span, 10 feet; minimum rod size, 1/2 inch.
10. 8 inches: Maximum span, 11 feet; minimum rod size, 5/8 inch.
11. 10 inches: Maximum span, 13 feet; minimum rod size, 3/4 inch.
12. 12 inches: Maximum span, 14 feet; minimum rod size, 7/8 inch.
13. 14 inches: Maximum span, 15 feet; minimum rod size, 1 inch.
14. 16 inches: Maximum span, 16 feet; minimum rod size, 1 inch.
15. 18 inches: Maximum span, 18 feet; minimum rod size, 1-1/4 inch.

END OF SECTION
SECTION 23 21 14
HYDRONIC SPECIALTIES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Air vents.
   B. Strainers.
   C. Flow indicators and controls.
   D. Relief valves.

1.02 RELATED REQUIREMENTS
   A. Section 23 21 13 - Hydronic Piping.
   B. Section 23 25 00 - HVAC Water Treatment: Pipe Cleaning.

1.03 SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
   C. Certificates: Inspection certificates for pressure vessels from authority having jurisdiction.
   D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
   E. Project Record Documents: Record actual locations of flow controls.
   F. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
   B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
   C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 AIR VENTS
   A. Manufacturers:
      2. ITT Bell & Gossett: www.bellgossett.com/#sle.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
   C. Float Type:
1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

D. Washer Type:
1. Brass with hygroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

E. Maximum Fluid Pressure: 150 psi.
F. Maximum Fluid Temperature: 250 degrees F.

2.02 STRAINERS

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Size 2 inch and Under:
1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

C. Size 2-1/2 inch to 4 inch:
1. Flanged iron body for 175 psi working pressure, Y pattern with 3/64 inch stainless steel perforated screen.

D. Size 5 inch and Larger:
1. Flanged iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.03 RELIEF VALVES

A. Manufacturers:
2. ITT Bell & Gossett: www.bellgossett.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install specialties in accordance with manufacturer’s instructions.
B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
C. Provide manual air vents at system high points and as indicated.
D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
E. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
F. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
G. Support pump fittings with floor mounted pipe and flange supports.
H. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.

I. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

J. Pipe relief valve outlet to nearest floor drain.

K. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION
SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Piping.
B. Refrigerant.
C. Moisture and liquid indicators.
D. Valves.
E. Strainers.
F. Check valves.
G. Pressure relief valves.
H. Filter-driers.
I. Solenoid valves.
J. Expansion valves.
K. Receivers.
L. Flexible connections.

1.02 REFERENCE STANDARDS
A. AHRI 495 - Performance Rating of Refrigerant Liquid Receivers.
B. AHRI 710 - Performance Rating of Liquid-Line Driers.
C. AHRI 730 (I-P) - Flow Capacity Rating of Suction Line Filters and Suction Line Filter Driers.
D. AHRI 750 - Thermostatic Refrigerant Expansion Valves.
E. AHRI 760 - Performance Rating of Solenoid Valves for Use With Volatile Refrigerants.
G. ASHRAE Std 34 - Designation and Safety Classification of Refrigerants.
H. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels.
I. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators.
J. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
K. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.
L. ASME B31.5 - Refrigeration Piping and Heat Transfer Components.
M. ASME B31.9 - Building Services Piping.
T. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
U. AWS D1.1/D1.1M - Structural Welding Code - Steel.
W. MSS SP-69 - Pipe Hangers and Supports - Selection and Application; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
X. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices; Manufacturers Standardization Society of the Valve and Fittings Industry, Inc..
Y. UL 429 - Electrically Operated Valves.

1.03 SYSTEM DESCRIPTION
A. 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.
B. Provide pipe hangers and supports in accordance with MSS SP-69 unless indicated otherwise.
C. Liquid Indicators:
   1. Use line size liquid indicators in main liquid line leaving condenser.
   2. If receiver is provided, install in liquid line leaving receiver.
   3. Use line size on leaving side of liquid solenoid valves.
D. Valves:
   1. Use service valves on suction and discharge of compressors.
   2. Use gage taps at compressor inlet and outlet.
   3. Use gage taps at hot gas bypass regulators, inlet and outlet.
   4. Use check valves on compressor discharge.
   5. Use check valves on condenser liquid lines on multiple condenser systems.
E. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
F. Strainers:
   1. Use line size strainer upstream of each automatic valve.
   2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
   3. On steel piping systems, use strainer in suction line.
   4. Use shut-off valve on each side of strainer.
G. Pressure Relief Valves: Use on ASME receivers and pipe to outdoors.
H. Filter-Driers:
   1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion valves, solenoid valves, and moisture indicators.
   2. Use a filter-drier on suction line just ahead of compressor.
   3. Use sealed filter-driers in lines smaller than 1/2 inch outside diameter.
   4. Use sealed filter-driers in low temperature systems.
   5. Use sealed filter-driers in systems utilizing hermetic compressors.
   6. Use replaceable core filter-driers in lines of 1/2 inch outside diameter or greater.
   7. Use replaceable core liquid-line filter-driers in systems utilizing receivers.
   8. Use filter-driers for each solenoid valve.
I. Solenoid Valves:
1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
2. Use in liquid line of single or multiple evaporator systems.
3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.

J. Receivers:
1. Use on systems five tons and larger, sized to accommodate pump down charge.
2. Use on systems with long piping runs.

K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.04 SUBMITTALS
A. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
B. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
C. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
D. Test Reports: Indicate results of leak test, acid test.
E. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
F. Submit welders certification of compliance with ASME (BPV IX) or AWS D1.1.
G. Project Record Documents: Record exact locations of equipment and refrigeration accessories on record drawings.
H. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.05 QUALITY ASSURANCE
A. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work.
B. Design piping system under direct supervision of a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 REGULATORY REQUIREMENTS
A. Conform to ASME B31.9 for installation of piping system.
B. Welding Materials and Procedures: Conform to ASME BPVC-IX and applicable state labor regulations.
C. Welders Certification: In accordance with ASME (BPV IX) or AWS D1.1.
D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Deliver and store piping and specialties in shipping containers with labeling in place.
B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.
1.08 MAINTENANCE PRODUCTS
   A. See Section 01 6000 - Product Requirements, for additional provisions.
   B. Provide two refrigeration oil test kits each containing everything required to conduct one test.
   C. Provide two filter-dryer cartridges of each type.

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION
   A. Filter-Driers:
      1. Use a filter-drier immediately ahead of liquid-line controls, such as thermostatic expansion
         valves, solenoid valves, and moisture indicators.

2.02 REGULATORY REQUIREMENTS

2.03 PIPING
   A. Copper Tube: ASTM B280, H58 hard drawn.
   B. Copper Tube to 7/8 inch OD: ASTM B88 (ASTM B88M), Type K (A), annealed.
   C. Pipe Supports and Anchors:
      1. Conform to ASTM F 708, MSS SP-58, MSS SP-69, and MSS SP-89.
      2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Carbon steel adjustable swivel, split ring.
      3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
      4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
      5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
      6. Wall Support for Pipe Sizes 4 Inches and Over: Welded steel bracket and wrought steel
         clamp.
      8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and
         concrete pier or steel support.
     10. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
     11. 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.

2.04 MOISTURE AND LIQUID INDICATORS
   A. Manufacturers:
   B. Indicators: Single or Doubleport type, UL listed, with copper or brass body, flared or solder
      ends, sight glass, color coded paper moisture indicator with removable element cartridge and
      plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500
      psi.

2.05 VALVES
   A. Manufacturers:
3. Flomatic Valves; Model ______: www.flomatic.com/#sle.

B. Diaphragm Packless Valves:
   1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.

C. Packed Angle Valves:
   1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

D. Ball Valves:
   1. Two piece bolted forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psi and maximum temperature of 300 degrees F.

E. Service Valves:
   1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.06 STRAINERS

A. Straight Line or Angle Line Type:
   1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

B. Straight Line, Non-Cleanable Type:
   1. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 500 psi.

2.07 CHECK VALVES

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Globe Type:
   1. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum temperature of 300 degrees F and maximum working pressure of 500 psi.

C. Straight Through Type:
   1. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psi and maximum temperature of 200 degrees F.

2.08 PRESSURE REGULATORS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Brass body, stainless steel diaphragm, direct acting, adjustable over 0 to 80 psi range, for maximum working pressure of 450 psi.
2.09 PRESSURE RELIEF VALVES

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB, selected to ASHRAE Std 15, with standard setting of 425 psi, adjusted to meet system requirements.

2.10 FILTER-DRIERS

A. Manufacturers:
   1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Performance:
   1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
   2. Flow Capacity - Suction Line: As indicated in schedule, minimum, rated in accordance with AHRI 730 (I-P).
   3. Water Capacity: As indicated in schedule, rated in accordance with AHRI 710.
   4. Pressure Drop: 2 psi, As indicated in schedule, maximum, when operating at full connected evaporator capacity.
   5. Design Working Pressure: As indicated in schedule or 350 psi, minimum.

C. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns; of construction that will not pass into refrigerant lines.

D. Construction: UL listed.
   1. Replaceable Core Type: Steel shell with removable cap.
   2. Sealed Type: Copper shell.
   3. Connections: As specified for applicable pipe type.

2.11 SOLENOID VALVES

A. Manufacturers:
   1. Flow Controls Division of Emerson Electric: www.emersonflowcontrols.com/#sle.

B. Valve: AHRI 760, pilot operated, copper or brass body and internal parts, synthetic seat, stainless steel stem and plunger assembly (permitting manual operation in case of coil failure), integral strainer, with flared, solder, or threaded ends; for maximum working pressure of 500 psi.

C. Coil Assembly: UL 429, UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.

D. Electrical Characteristics: per drawings.

2.12 EXPANSION VALVES

A. Manufacturers:
1. Flow Controls Division of Emerson Electric:  www.emersonflowcontrols.com/#sle.

B. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, mechanical pressure limit (maximum operating pressure MOP feature), adjustable superheat setting, replaceable inlet strainer, with replaceable capillary tube and remote sensing bulb and remote bulb well.

C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.13 ELECTRONIC EXPANSION VALVES

A. Manufacturers:

B. Valve:
   1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
   2. Capacity: per drawings.

C. Evaporation Control System:
   1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, preselection allowance for electrical defrost and hot gas bypass.
   2. Electrical Characteristics: per drawings.

D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.14 RECEIVERS

A. Manufacturers:

B. Internal Diameter 6 inch and Smaller:
   1. AHRI 495, UL listed, steel, brazed; 400 psi maximum pressure rating, with tappings for inlet, outlet, and pressure relief valve.

C. Internal Diameter Over 6 inch:
   1. AHRI 495, welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; 400 psi with tappings for liquid inlet and outlet valves, pressure relief valve, and magnetic liquid level indicator.

2.15 FLEXIBLE CONNECTORS

A. Manufacturers:
B. Corrugated stainless steel or bronze hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

**PART 3 EXECUTION**

### 3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt on inside and outside before assembly.

C. Prepare piping connections to equipment with flanges or unions.

### 3.02 INSTALLATION

A. Install refrigeration specialties in accordance with manufacturer's instructions.

B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.

C. Install piping to conserve building space and avoid interference with use of space.

D. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.

E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

F. Inserts:
   1. Provide inserts for placement in concrete formwork.
   2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
   3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
   4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
   5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of or recessed into and grouted flush with slab.

G. Pipe Hangers and Supports:
   1. Install in accordance with ASTM F 708 and MSS SP-89.
   2. Support horizontal piping as scheduled.
   3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
   4. Place hangers within 12 inches of each horizontal elbow.
   6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
   7. Provide copper plated hangers and supports for copper piping.

H. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.

I. Provide clearance for installation of insulation and access to valves and fittings.

J. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Section 08 31 00.

K. Flood piping system with nitrogen when brazing.

L. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
M. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to Section 09 90 00.

N. Insulate piping and equipment; refer to Section 09 07 16.

O. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.

P. Provide replaceable cartridge filter-driers, with isolation valves and valved bypass.

Q. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.

R. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.

S. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.

T. Fully charge completed system with refrigerant after testing.

U. Provide electrical connection to solenoid valves. Refer to Section 26 27 17.

3.03 FIELD QUALITY CONTROL

A. Test refrigeration system in accordance with ASME B31.5.

B. Pressure test system with dry nitrogen to 200 psi. Perform final tests at 27 inches vacuum and 200 psi using electronic leak detector. Test to no leakage.

3.04 SCHEDULES

A. Hanger Spacing for Copper Tubing.
   1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 3/8 inch.
   2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 3/8 inch.
   3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   6. 2-5/8 inch OD: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   7. 3-1/8 inch OD: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   8. 3-5/8 inch OD: Maximum span, 11 feet; minimum rod size, 1/2 inch.
   9. 4-1/8 inch OD: Maximum span, 12 feet; minimum rod size, 1/2 inch.

B. Hanger Spacing for Steel Piping.
   1. 1/2 inch, 3/4 inch, and 1 inch: Maximum span, 7 feet; minimum rod size, 3/8 inch.
   2. 1-1/4 inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
   3. 1-1/2 inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
   4. 2 inches: Maximum span, 10 feet; minimum rod size, 3/8 inch.
   5. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
   6. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
   7. 4 inches: Maximum span, 12 feet; minimum rod size, 1/2 inch.

END OF SECTION
SECTION 23 31 00
HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Metal ductwork.
B. Casing and plenums.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete.
B. Section 09 90 00 - Painting and Coating: Weld priming, weather resistant, paint or coating.
C. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
D. Section 23 33 00 - Air Duct Accessories.
E. Section 23 36 00 - Air Terminal Units.
F. Section 23 37 00 - Air Outlets and Inlets.
G. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

1.03 REFERENCE STANDARDS
B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
O. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; Sheet Metal and Air Conditioning Contractors' National Association.

P. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.

Q. SMACNA (FGD) - Fibrous Glass Duct Construction Standards.

R. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

S. IECC 2012 - International Energy Conservation Code - Duct construction standards, leakage testing

1.04 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.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide data for duct materials and duct connections.
C. Shop Drawings: Indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for all systems.
D. Manufacturer's Certificate: Certify that installation of glass fiber ductwork meet or exceed recommended fabrication and installation requirements.
E. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.06 QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Installer Qualifications: Company specializing in performing the type of work specified in this section, with minimum five years of documented experience.

1.07 REGULATORY REQUIREMENTS
A. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

1.08 FIELD CONDITIONS
A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
B. Maintain temperatures within acceptable range during and after installation of duct sealants.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

2.02 MATERIALS
A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G90/Z275 coating.
C. Stainless Steel for Ducts: ASTM A 240/A 240M, Type 304.
D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
E. Flexible Ducts:
1. Two ply vinyl film supported by helically wound spring steel wire.
   a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
   b. Maximum Velocity: 4000 fpm.
   c. Temperature Range: -10 degrees F to 160 degrees F.

F. Insulated Flexible Ducts:
1. Two ply vinyl film supported by helically wound spring steel wire; fiberglass insulation; polyethylene vapor barrier film.
   a. Pressure Rating: 10 inches WG positive and 1.0 inches WG negative.
   b. Maximum Velocity: 4000 fpm.
   c. Temperature Range: -10 degrees F to 160 degrees F.

G. Stainless Steel Ducts: ASTM A 666, Type 304.

H. All Ducts: Galvanized steel, unless otherwise indicated.

I. Low Pressure Supply (Heating Systems): 1 inch w.g. pressure class, galvanized steel.

J. Low Pressure Supply (System with Cooling Coils): 1 inch w.g. pressure class, galvanized steel.

K. Medium and High Pressure Supply (All VAV Primary Supply Duct between AHU and VAV Terminal Unit): 2 inch w.g. pressure class, galvanized steel.

L. Return and Relief: 1 inch w.g. pressure class, galvanized steel.

M. General Exhaust: 1 inch w.g. pressure class, galvanized steel.

N. Dishwasher Exhaust: 1/2 inch w.g. pressure class, stainless steel.

O. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
   1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
   2. VOC Content: Not more than 250 g/L, excluding water.

P. Grease Exhaust: 1/2 inch w.g. pressure class, stainless steel.
   1. Construct of 18 gauge stainless steel.
   2. Construction:
      a. Liquid tight with continuous external weld for all seams and joints.
      b. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
   3. Access Doors:
      a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
      b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.
   4. Surface Burning Characteristics: Flame spread of zero, smoke developed of zero, when tested in accordance with ASTM E 84.

2.03 DUCTWORK FABRICATION
A. Fabricate and support in accordance with SMACNA HVAC Duct Construction Standards and as indicated.
B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
C. 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 must be used, provide turning vanes.
D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA HVAC Duct Construction Standards.
F. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
H. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.04 MANUFACTURED DUCTWORK AND FITTINGS
A. Manufacture in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
B. Double Wall Insulated Round Ducts: Round spiral lockseam duct with paintable galvanized steel outer wall, perforated galvanized steel inner wall; fitting with solid inner wall. Provide paint in color selected by architect.
   1. Manufacture in accordance with SMACNA HVAC Duct Construction Standards.
   2. Insulation:
      a. Thickness: 2 inch.
      b. Material: Fiberglass, with mylar coating between insulation and perforated liner.
C. Transverse Duct Connection System: SMACNA "J" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips.

2.05 CASINGS
A. Fabricate casings in accordance with SMACNA HVAC Duct Construction Standards and construct for operating pressures indicated.
B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
C. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
D. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.
   1. Provide clear wire glass observation ports, minimum 6 X 6 inch size.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install, support, and seal ducts in accordance with SMACNA HVAC Duct Construction Standards.
B. Install in accordance with manufacturer's instructions.
C. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.

D. Install and seal metal and flexible ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.

E. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot 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.

F. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

G. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.

H. Use double nuts and lock washers on threaded rod supports.

I. Tape joints of PVC coated metal ductwork with PVC tape.

J. Connect terminal units to supply ducts with one foot maximum length of flexible duct. Do not use flexible duct to change direction.

K. Connect diffusers or light troffer boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.

L. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

M. Set plenum doors 6 to 12 inches above floor. Arrange door swings so that fan static pressure holds door in closed position.

N. Use stainless steel for ductwork exposed to view and stainless steel or carbon steel for ducts where concealed.

O. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

P. At exterior wall louvers, seal duct to louver frame and install blank-out panels as required.

3.02 RANGE HOOD EXHAUST DUCT INSTALLATIONS

A. Install ducts to allow for thermal expansion of ductwork through 2000 deg F temperature range.

B. Provide residue traps in kitchen hood exhaust ducts at base of vertical risers with provisions for clean out.

C. Install ducts without dips or traps that may collect residues, unless traps have continuous or automatic residue removal.

D. Install access openings at each change in direction and at 50-foot intervals; locate on sides of duct a minimum of 1-1 1/2 inches from bottom; and fit with grease-tight covers of same material as duct.

E. Do not penetrate fire-rated assemblies.

3.03 CLEANING AND TESTING

A. Conduct required duct-leakage testing as defined within this specification and otherwise noted in the contract documents.

3.04 SCHEDULES

A. Ductwork Material:
   2. Low Pressure Supply (System with Cooling Coils): Steel, Aluminum.
   4. Return and Relief: Steel, Aluminum.
5. General Exhaust: Steel, Aluminum.
7. Outside Air Intake: Steel.

B. Ductwork Pressure Class:
1. Supply (Heating Systems): 1 inch
2. Supply (System with Cooling Coils): 2 inch.
3. Return and Relief: 1 inch.
4. General Exhaust: 1 inch.
5. Outside Air Intake: 1 inch.

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Air turning devices/extractors.
   B. Backdraft dampers.
   C. Combination fire and smoke dampers.
   D. Duct access doors.
   E. Duct test holes.
   F. Fire dampers.
   G. Flexible duct connections.
   H. Smoke dampers.
   I. Volume control dampers.

1.02 REFERENCE STANDARDS
   C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible.
   D. UL 555S - Standard for Smoke Dampers.

1.03 SUBMITTALS
   A. See Section 01 33 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.
   C. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers.
   D. Project Record Drawings: Record actual locations of access doors and test holes.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
   B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS
   A. Manufacturers:
      5. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Multi-blade device with radius blades attached to pivoting frame and bracket, steel construction, with push-pull operator strap.
2.02 BACKDRAFT DAMPERS
   A. Manufacturers:
      5. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 COMBINATION FIRE AND SMOKE DAMPERS

2.04 DUCT ACCESS DOORS
   A. Manufacturers:
      5. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
      1. Less Than 12 inches Square: Secure with sash locks.
      2. Up to 18 inches Square: Provide two hinges and two sash locks.
      3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
      4. Larger Sizes: Provide an additional hinge.
   C. Access doors with sheet metal screw fasteners are not acceptable.

2.05 DUCT TEST HOLES
   A. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
   B. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.06 FIRE DAMPERS
   A. Manufacturers:
      7. Substitutions: See Section 01 60 00 - Product Requirements.

2.07 FLEXIBLE DUCT CONNECTIONS
   A. Fabricate in accordance with SMACNA (DCS) and as indicated.
   B. Flexible Duct Connections: Fabric crimped into metal edging strip.
      1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
2.08 SMOKE DAMPERS

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.

C. Electro Thermal Link: Fusible link melting at 165 degrees F; UL listed and labeled.

2.09 VOLUME CONTROL DAMPERS

A. Manufacturers:
5. Substitutions: See Section 01 60 00 - Product Requirements.

B. Fabricate in accordance with SMACNA (DCS) and as indicated.

C. Splitter Dampers:
1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.

D. Single Blade Dampers: Fabricate for duct sizes up to 6 x 30 inch.

E. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.

F. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 31 00 for duct construction and pressure class.

B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide minimum 8 x 8 inch size for hand access, 18 x 18 inch size for shoulder access, and as indicated. Provide 4 x 4 inch for balancing dampers only. Review locations prior to fabrication.

D. Provide duct test holes where indicated and required for testing and balancing purposes.

E. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
F. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.

G. Demonstrate re-setting of fire dampers to Owner's representative.

H. At fans and motorized equipment associated with ducts, provide flexible duct connections immediately adjacent to the equipment.

I. At equipment supported by vibration isolators, provide flexible duct connections immediately adjacent to the equipment.

J. 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 2 duct widths from duct take-off.

K. Use splitter dampers only where indicated.

END OF SECTION
SECTION 23 36 00
AIR TERMINAL UNITS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Variable volume terminal units.

1.02  RELATED REQUIREMENTS
A. Section 23 31 00 - HVAC Ducts and Casings.
B. Section 23 33 00 - Air Duct Accessories.
C. Section 23 37 00 - Air Outlets and Inlets.
D. Section - Instrumentation and Control Devices for HVAC: Thermostats and Actuators.

1.03  REFERENCE STANDARDS
A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
C. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.04  SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
D. Manufacturer’s Installation Instructions: Indicate support and hanging details, and service clearances required.
E. Project Record Documents: Record actual locations of units.
F. Operation and Maintenance Data: Include manufacturer’s descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.
G. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.

1.05  QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06  WARRANTY
A. See Section 01 77 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturer warranty for air terminal units.

PART 2  PRODUCTS

2.01  MANUFACTURERS
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 MANUFACTURED UNITS
A. Ceiling mounted variable air volume supply air control terminals for connection to single duct, central air systems, with electronic variable volume controls, hot water heating coils.
B. Identify each terminal unit with clearly marked identification label and air flow indicator. Include unit nominal air flow, maximum factory set airflow, minimum factory set air flow, and coil type.

2.03 SINGLE DUCT VARIABLE VOLUME UNITS
A. Basic Assembly:
   2. Lining: Minimum 1/2 inch thick foil coated or vinyl coated fibrous glass insulation, 1.5 lb/cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
   3. Plenum Air Inlets: S slip and drive connections for duct attachment.
B. Basic Unit:
   3. Volume Damper: Construct of galvanized steel with peripheral gasket and self lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.
   4. Mount damper operator to position damper normally open.
C. Electric Heating Coil:
   1. Listed, open-coil design, factory-installed and slip-in-type, fully wired including integral control box.
   2. 80/20 nickel-chrome heating elements.
   3. Integral Control Panel: NEMA 250, Type 2 enclosure with hinged access door for access to all controls and safety devices.
   5. Electric-pneumatic relays and switches.
   7. Airflow switch.
   8. Disconnect switch (non-interlocking).
   10. Provide SCR (Silicon Controlled Rectifier) controller.
D. Automatic Damper Operator:
   1. Electric Actuator: See schedules.
E. Flow Sensor:
   1. Center-mount averaging flow sensor with plenum-rated tubing.

PART 3 EXECUTION
3.01 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Support units individually from structure. Do not support from adjacent ductwork.
C. Connect to ductwork in accordance with Section 23 31 00.
D. Verify that electric power is available and of the correct characteristics.
3.02 ADJUSTING

A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

END OF SECTION
SECTION 23 37 00  
AIR OUTLETS AND INLETS

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Diffusers.
   1. Perforated ceiling diffusers.
B. Rectangular ceiling diffusers.
C. Registers/grilles.
D. Louvers.
E. Gravity ventilators.

1.02  RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating: Painting of ducts visible behind outlets and inlets.

1.03  REFERENCE STANDARDS
A. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating.
B. ASHRAE Std 70 - Method of Testing the Performance of Air Outlets and Air Inlets.

1.04  SUBMITTALS
A. See Section 01 33 00 - Administrative Requirements for submittal procedures.
B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
C. Samples: Submit one of each required air outlet and inlet type.
D. Project Record Documents: Record actual locations of air outlets and inlets.

1.05  QUALITY ASSURANCE
A. Test and rate air outlet and inlet performance in accordance with ASHRAE Std 70.
B. Test and rate louver performance in accordance with AMCA 500-L.

1.06  QUALITY ASSURANCE
A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.07  MOCK-UP
A. Provide mock-up of typical interior ceiling module with supply and return air outlets.
B. Locate where directed or as indicated on drawings.
C. Mock-up may remain as part of the Work, if approved.

PART 2  PRODUCTS

2.01  MANUFACTURERS
E. Tuttle and Bailey: www.tuttleandbailey.com/#sle.
F. Substitutions: See Section 01 60 00 - Product Requirements.
2.02 RECTANGULAR CEILING DIFFUSERS
   A. Type: Square; multi-core diffuser to discharge air in 360 degree pattern.
   B. Frame: Surface mount; Snap-in; Inverted T-bar or as indicated.
   C. Color: As selected by Architect from manufacturer's standard range.
   D. Fabrication: Aluminum with baked enamel off-white finish.
   E. Accessories: Radial opposed blade or Combination splitter as indicated and multi-louvered equalizing grid with damper adjustable from diffuser face.

2.03 PERFORATED FACE CEILING RETURN AIR GRILLES
   A. Type: Perforated face with fully adjustable pattern and removable face.
   B. Frame: Surface mount; Snap-in; Inverted T-bar; or Spline type as indicated.
   C. Color: As selected by Architect from manufacturer's standard range.
   D. Fabrication: aluminum and baked enamel off-white finish.

PART 3 EXECUTION

3.01 INSTALLATION
   A. Install in accordance with manufacturer's instructions.
   B. Check location of outlets and inlets and make necessary adjustments in position to conform with architectural features, symmetry, and lighting arrangement.
   C. Install diffusers to ductwork with air tight connection.
   D. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
   E. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 90 00.

3.02 SCHEDULES

3.03 AIR OUTLET AND INLET SCHEDULE
   A. See Drawings

END OF SECTION
SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Energy recovery ventilators.

1.02 REFERENCE STANDARDS
   A. AHRI 1060 (I-P) - Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment.
   B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   D. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks.
   G. NFPA 70 - National Electrical Code.
   I. UL (DIR) - Online Certifications Directory.
   J. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittal procedures.

1.04 QUALITY ASSURANCE
   A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with at least five years of documented experience.
   B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

1.05 DELIVERY, STORAGE, AND HANDLING
   A. See Section 01 74 19 - Construction Waste Management and Disposal for packaging waste requirements.

1.06 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.
   B. Manufacturer Warranty: Provide 1-year manufacturer warranty for equipment including parts, materials, workmanship, and operation commencing on date of Substantial Completion. Complete forms in Owner's name and register with manufacturer.
   C. Motor Warranty: Provide 36-month manufacturer warranty against breakdowns, malfunctions, or defects in material and workmanship under expected service conditions.
   D. Energy Wheel Warranty: Provide 5-year manufacturer warranty against desiccant coating or wheel or core material and workmanship defects including issues arising from reduced performance under circumstances of normal use from listed design figures.
PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. RenewAire; www.renewaire.com/#sle.
   B. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 ENERGY RECOVERY VENTILATOR
   A. ERV Equipment Construction Requirements:
      1. Energy Recovery Exchanger Type: Membrane plate.
      2. Supply and Return Duct Connection Orientation: As indicated on drawings.
      3. Casing and Frame:
         a. Frame: Galvanized steel body or welded extruded aluminum tubular frame capable of supporting components and casings including integral base lifting holes.
         b. Double Wall Panels: Minimum of 18 gauge, 0.040 inch galvanized steel.
         c. Doors: Construct doors of same construction and thickness as wall panels. Include p-shaped extruded neoprene gasket, prop rod, chain with spring, exterior handle, and interior 3-point latching device. Label each door to identify equipment located within.
         d. Insulation Requirements:
            1) Mold Resistance: "Pass" when tested in accordance with ASTM C1338.
            2) Fungal Resistance: No growth when tested in accordance with ASTM G21.
            3) Bacteria Resistance: No growth when tested in accordance with UL 181.
            4) Flame spread index of 25 or less and maximum smoke developed index of 50.
         e. Isolation and Sealing: Form continuous, thermally isolated, weathertight seal between inner wall of panels and structural framing with closed cell PVC foam gasketing and seal seams to prevent job site caulking.
         f. Access Panels: Provide access to components through a large, tightly sealed and easily removable hinged or screwed access panel.
         g. Finish: Polyurethane enamel over weather-protected, corrosion-resistant assembly.
         h. Nameplate: Permanent name plate listing manufacturer, model number, serial number, voltage with tolerance, and amp ratings mounted inside door near electrical panel.
      4. Supply and Exhaust Fans:
         a. Provide separate non-overloading, statically and dynamically balanced, draw-through, forward curved centrifugal fan or fan-array for each air stream.
         b. Fan Motor: Constant Speed, high efficiency, load matched, belt-driven, open drip proof, thermal overload protected TEFC motor with variable-sheave belt drive, and adjustable-removable motor-slide base. Size drives to 150 percent of load, minimum.
         c. Belt Guards: Full sized, hinged, painted with high-visibility safety color, and accessible with standard tools.
         d. Motor Bearings: Permanently lubricated sealed ball bearings rated for not less than 200,000 hours of operation with accessible greased fittings.
      5. Filter Sections:
         a. Outdoor-Intake and Exhaust Sides: 2 inch thick, pleated, MERV 13 filters, ASHRAE Std 52.2.
         b. Filter Racks: Bolt-on rack constructed of aluminum with minimum size of 1/12 inch thick. Include hinged side access door and snap fasteners.
      6. Roof Curbs:
         a. Curbs: Provide full perimeter, watertight, sloped, weight-supporting roof curb fabricated from minimum of 10 gauge, 0.1345 inch aluminized steel.
b. Isolation Rails: Provide factory-installed, 12 gauge, 0.1046 inch aluminized steel angles top and bottom, connected with flexible, outdoor rated membrane and factory-installed vibration isolation springs.

c. Gaskets: Provide closed cell PVC foam, field installed top of curb.


8. Electrical:
   a. 480 VAC, 3-phase with single-point power connection to nonfused main disconnect interlocked with control panel and other components.
   b. Install internal wiring in accordance with NFPA 70 within flexible, liquid tight steel conduit.

9. Controls and Local Control Panel:
   a. Unit Controls: Factory supplied DDC with sensors, limit switches, and frost control.
   b. Provide fused disconnect within local control panel with power supplies, transformers, terminal strip or terminal blocks for interface of field installed components.
   c. Service Status: Provide both local and remote indication of sensor readings and status of safeties and other status items including power on, wheel-rotation alarm, outside-air loaded filter and exhaust-air loaded filter.
   d. Provide temperature, humidity, dewpoint temperature, CO2, and wheel rotation sensors.
   e. Freeze Protection Thermostat: Provide and configure to stop unit when outdoor air intake temperature drops below 38 degrees F, adjustable.

10. BAS, SCADA, or other Integrated Automation Link: ASHRAE Std 135, BACnet MS/TP.
11. Configuration: Adjust listed requirements in conformance with ASHRAE Std 90.1 I-P.
12. Certification: AHRI 1060 (I-P) labeled, include copy of published ratings for operating conditions.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that structure is ready for installation including openings, ductwork, mechanical utilities, and electrical utilities.

3.02 INSTALLATION
   A. Install equipment in accordance with manufacturer's written installation instructions.
   B. Do not obstruct maintenance access to equipment piping, electrical conduit, or any other utility.
   C. Vibration Isolation: Provide corrosion-resistant equipment isolation products; see Section 23 05 48.
   D. Electrical: Provide equipment raceway, wiring, and cables; see Section 26 27 17.
   E. Coordinate installation and fire alarm system interface of system compatible duct-mounted smoke detectors and other appurtenances following NFPA 90A guidelines.
   F. Start system and adjust controls and equipment for satisfactory operation.
   G. Coordinate hardwired or software interfacing links to enable coordinate as minimum start-stop, occupied, unoccupied functions as well as specific schedules and setpoints functions with other DDC controls onboard airside systems serving common spaces; see Section 23 09 23.
   H. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 15 00.

3.03 SYSTEM STARTUP
   A. Provide services of manufacturer's authorized representative to provide start up of unit.
3.04 CLEANING
   A. See Section 01 70 00 - Execution and Closeout Requirements for additional requirements.
   B. Clean filters, air plenums, interior and exposed-to-view surfaces prior to Substantial Completion.

3.05 CLOSEOUT ACTIVITIES
   A. Demonstrate proper operation of equipment to Owner’s designated representative.
SECTION 23 81 26.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1  GENERAL

1.01  SECTION INCLUDES

A. Air-source heat pumps.
B. Indoor air handling (fan and coil) units for ducted systems.
C. Indoor air handling (fan and coil) units for ductless systems.
D. Controls.

1.02  REFERENCE STANDARDS

C. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units.
F. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical.

1.03  SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.
D. Design Data: Indicate refrigerant pipe sizing.
E. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.
F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.
G. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.
H. Project Record Documents: Record actual locations of components and connections.
I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Filters: One for each unit.

1.04  QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum 5 years of documented experience.

1.05  WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Provide five year manufacturers warranty for compressors and refrigeration systems.
PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Daikin.
B. Mitsubishi
C. Samsung
D. LG
E. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.
   1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTED SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heating and cooling element(s), controls, and accessories; wired for single power connection with control transformer.
   2. Cabinet: Steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.

B. Supply Fan: Centrifugal, direct drive, dynamically balanced for variable speed use.
   1. Motor: ECM; multiple speed, permanently lubricated
   2. Motor Electrical Characteristics:

C. Air Filters: 1 inch thick urethane, washable type arranged for easy replacement.

D. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

2.04 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
   1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

2.05 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.
   1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

B. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.
C. Operating Controls:
   1. Control by room thermostat to maintain room temperature setting.

PART 3  EXECUTION

3.01  EXAMINATION
A. Verify that substrates are ready for installation of units and openings are as indicated on shop drawings.
B. Verify that proper power supply is available and in correct location.
C. Verify that proper fuel supply is available for connection.

3.02  INSTALLATION
A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
B. Install in accordance with NFPA 90A and NFPA 90B.
C. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION
SECTION 23 81 29
VARIABLE REFRIGERANT VOLUME (VRV, VRF) HVAC SYSTEM

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Variable refrigerant volume HVAC system includes:
      1. Outdoor/Condensing unit(s).
      2. Indoor/Evaporator units.
      3. Branch selector units.
      4. Refrigerant piping.
      5. Control panels.
      6. Control wiring.

1.02 RELATED REQUIREMENTS
   A. Section 01 23 00 - Alternates: List of alternates relevant to this section.
   B. Section 01 79 00 - Demonstration and Training.
   C. Section 22 10 05 - Plumbing Piping: Condensate drain piping.
   D. Section 22 30 00 - Plumbing Equipment: Cooling condensate removal pumps.
   E. Section 23 08 00 - Commissioning of HVAC.
   F. Section 23 23 00 - Refrigerant Piping and Specialties: Additional requirements for refrigerant piping system.
   G. Section 26 27 17 - Equipment Wiring: Power connections to equipment.
      1. Provide separate power connections for each unit of equipment.
   H. Section 23 09 23 and 23 09 93: Building automation system providing centralized control of this system.
   I. Section 01 91 00 - Commissioning
   J. Section 01 91 10 - Functional Testing Procedures
   K. Section 23 08 00 - Mechanical Systems Commissioning
   L. Section 23 08 10 - Control Systems Commissioning

1.03 REFERENCE STANDARDS
   D. NFPA 70 - National Electrical Code.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Pre-Bid Submittals: For proposed substitute systems/products, as defined in PART 2, and alternate systems/products, as defined above, proposer shall submit all data described in this article, under the terms given for substitutions stated in PART 2.
C. Design Data:
   1. Provide design calculations showing that system will achieve performance specified.
   2. Provide design data required by ASHRAE 90.1.

D. Product Data: Submit manufacturer's standard data sheets showing the following for each item of equipment, marked to correlate to equipment item markings shown in the contract documents:
   1. Control Panels: Complete description of options, control points, zones/groups.

E. Specimen Warranty: Copy of manufacturer's warranties.

F. Shop Drawings: Installation drawings custom-made for this project; include as-designed HVAC layouts, locations of equipment items, refrigerant piping sizes and locations, condensate piping sizes and locations, remote sensing devices, control components, electrical connections, control wiring connections. Include:
   1. Detailed piping diagrams, with branch balancing devices.
   2. Condensate piping routing, size, and pump connections.
   3. Detailed power wiring diagrams.
   4. Detailed control wiring diagrams.
   5. Locations of required access through fixed construction.
   6. Drawings required by manufacturer.

G. Operating and Maintenance Data:
   1. Manufacturer's complete standard instructions for each unit of equipment and control panel.
   2. Custom-prepared system operation, troubleshooting, and maintenance instructions and recommendations.
   3. Identification of replaceable parts and local source of supply.

H. Project Record Documents: Record the following:
   1. As-installed routing of refrigerant piping and condensate piping.
   2. Locations of access panels.
   3. Locations of control panels.

I. Warranty: Executed warranty, made out in Owner's name.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Company that has been manufacturing variable refrigerant volume heat pump equipment for at least 5 years.
   2. Company that provides system design software to installers.

B. Installer Qualifications: Trained and approved by manufacturer of equipment.

1.07 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle equipment and refrigerant piping according to manufacturer's recommendations.

1.08 EXTRA MATERIALS

A. Provide 2-piece filter assemblies for indoor ducted units.
B. Provide two (2) spare filter sets for each indoor unit.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
B. Compressors: Provide manufacturer's warranty for six (6) years from date of installation. During the stated period, should any part fail due to defects in material and workmanship, it
shall be repaired or replaced by the manufacturer. All warranty service work shall be preformed by a factory trained service professional.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Basis of Design: The system design shown in the contract documents is based on equipment and system designed by Samsung.
B. Additional acceptable manufacturers:
1. Daikin.
2. Mitsubishi.
3. LG.
C. For systems proposed by other manufacturers other than the basis of design, Samsung, all required modifications to the design and installation shall be the responsibility of the contractor and supplier for both costs and coordination with all other contractors and designers. These changes include, but are not limited to:
   1. Changes in refrigerant piping sizes, lengths, and locations.
   2. Changes in branch selector quantities, locations, and accessibility.
   3. Changes in electrical requirements, including all power wiring, terminations, breakers, disconnects, and control wiring.
   5. Changes in structural supports, vibration isolation, and hangers.
   6. Changes to the drawings to reflect the new system parameters.

2.02 HVAC SYSTEM DESIGN
A. System Operation: Heating and cooling, simultaneously.
   1. Zoning: Provide capability for temperature control for each individual indoor/evaporator unit independently of all other units.
   2. Zoning: Provide heating/cooling selection for each individual indoor/evaporator unit independently of all other units.
   3. Provide a complete functional system that achieves the specified performance based on the specified design conditions and that is designed and constructed according to the equipment manufacturer's requirements.
   4. Conditioned spaces are shown on drawings.
   5. Branch selector unit locations are shown on the drawings for reference only. Final design locations shall be coordinated in the field to ensure optimized line lengths and maintenance access.
   6. Required equipment unit capacities are shown on the drawings.
   7. Refrigerant piping sizes shown on the drawings are for general reference only. Final line sizing shall be the responsibility of the successful contractor and manufacturer.
   8. Connect equipment to condensate piping; condensate piping is shown on the drawings.
B. Cooling Mode Interior Design Performance:
   1. Daytime Setpoint: 75 degrees F, plus or minus 2 degrees F.
   2. Setpoint Range: 57 degrees F to 80 degrees F.
   3. Night Setback: 78 degrees F.
   4. Interior Relative Humidity: 50 percent, maximum.
C. Heating Mode Interior Design Performance:
   1. Daytime Setpoint: 70 degrees F, plus or minus 2 degrees F.
   2. Setpoint Range: 59 degrees F to 76 degrees F.
   3. Night Setback: 60 degrees F.
   4. Interior Relative Humidity: 20 percent, minimum.
D. Outside Air Design Conditions:
   1. Summer Outside Air Design Temperature: 0.4 percent cooling design condition listed in ASHRAE Fundamentals Handbook.

E. Operating Temperature Ranges:
   1. Simultaneous Heating and Cooling Operating Range: minus 4 degrees F to 60 degrees F dry bulb.
   2. Cooling Mode Operating Range: minus 4 degrees F to 110 degrees F dry bulb.
   3. Heating Mode Operating Range: 0 degrees F to 77 degrees F dry bulb; minus 4 degrees F to 60 degrees F wet bulb; without low ambient controls or auxiliary heat source.

F. Controls: Provide the following control interfaces:
   1. For Each Indoor/Evaporator Unit: One wall-mounted wired "local" controller, with temperature sensor; locate where directed, in each space.
      a. Where two or more units are used to condition the same space, provide a splitter or twinning kit to allow for multiple unit control from a single controller.
   2. One central remote control panel for entire system; locate where indicated.
   3. BACNet gateways sufficient to connect all units to building automation system by others; include wiring to gateways. Unit shall be BTL certified.
   4. Building automation system by HVAC system manufacturer; provide one user stations located where indicated.
   5. Local Controllers: Mount units above ceiling for use with remote, flat-plate temperature sensors. Units shall be wired, and provide local setpoint adjustment (with central control override, maximum temperature adjustment), and temperature display for trouble-shooting.

G. Remote Temperature Sensors: Provide wall-mounted, flush-mount flat-plate style RTD temperature sensors located in the same room for all units. For rooms with multiple units, provide twinning kits for simultaneous control.

2.03 EQUIPMENT

A. All Units: Factory assembled, wired, and piped and factory tested for function and safety.
   1. Refrigerant: R-410A.
   3. Safety Certification: Tested to UL 1995 by UL or Intertek-ETL and bearing the certification label.
   4. Provide outdoor/condensing units capable of serving indoor unit capacity up to 200 percent of the capacity of the outdoor/condensing unit.
   5. Provide units capable of serving the zones indicated.
   6. Thermal Performance: Provide heating and cooling capacity as indicated, based on the following nominal operating conditions:
      a. Cooling: Indoor air temperature of 75 degrees F dry bulb, 50% RH; outdoor air temperature of 89.1 degrees F dry bulb, 73.2 degrees wet bulb.
      b. Heating: Indoor air temperature of 72 degrees F dry bulb; outdoor air temperature of 6.1 degrees dry bulb.

B. Electrical Characteristics:
   1. See drawings.

C. System Controls:
   1. Include self diagnostic, auto-check functions to detect malfunctions and display the type and location.
D. Unit Controls: As required to perform input functions necessary to operate system; provided by manufacturer of units.
   1. Provide interfaces to remote control and building automation systems in BACNET native format.

E. Wiring:
   2. Control Wiring Configuration: Daisy chain.
   3. All control wiring for the VRF system in its entirety is the responsibility of the installing contractor, including, but not limited to: Wiring between the condensing unit(s) and system controller, wiring between the branch selector boxes and system controller, wiring from the terminal units to the system controllers, wiring from the thermostats to the terminal units. The BAS contractor shall only be required to provide communications wiring to the BACnet interface from the nearest BAS controller.

F. Refrigerant Piping:
   1. Provide three-pipe refrigerant system, including high/low pressure dedicated hot gas, liquid and suction lines; two-pipe systems utilizing lower temperature mixed liquid/gas refrigerant to perform heat recovery are not permitted due to reduced heating capabilities.
   2. Refrigerant Flow Balancing: Provide refrigerant piping joints and headers specifically designed to ensure proper refrigerant balance and flow for optimum system capacity and performance.
   3. Insulate each refrigerant line individually between the condensing and indoor units.

2.04 OUTDOOR/CONDENSING UNITS

A. Outdoor/Condensing Units: Air-cooled DX refrigeration units, designed specifically for use with indoor/evaporator units; factory assembled and wired with all necessary electronic and refrigerant controls; modular design for ganging multiple units.
   1. Refrigeration Circuit: Scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator.
   2. Refrigerant: Factory charged.
   3. Variable Volume Control: Modulate compressor capacity automatically to maintain constant suction and condensing pressures while varying refrigerant volume to suit heating/cooling loads.
   4. Capable of being installed with wiring and piping to the left, right, rear or bottom.
   5. Capable of heating operation at low end of operating range as specified, without additional low ambient controls or auxiliary heat source; during heating operation, reverse cycle (cooling mode) oil return or defrost is not permitted, due to potential reduction in space temperature.
   6. Sound Pressure Level: As specified, measured at 3 feet from front of unit; provide night setback sound control as a standard feature; three selectable sound level steps of 55 dB, 50 dB, and 45 dB, maximum.
   7. Power Failure Mode: Automatically restart operation after power failure without loss of programmed settings.
   8. Safety Devices: High pressure sensor and switch, low pressure sensor/switch, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
   9. Provide refrigerant sub-cooling to ensure the liquid refrigerant does not flash when supplying to us indoor units.
   10. Oil Recovery Cycle: Automatic, occurring 2 hours after start of operation and then every 8 hours of operation; maintain continuous heating during oil return operation.
11. Controls: Provide contacts for electrical demand shedding.

B. Unit Cabinet: Weatherproof and corrosion resistant; rust-proofed mild steel panels coated with baked enamel finish.
   1. Designed to allow side-by-side installation with minimum spacing.

C. Fans: One or more direct-drive propeller type, vertical discharge, with multiple speed operation via DC (digitally commutating) inverter.
   1. Provide minimum of 2 fans for each condensing unit.
   2. External Static Pressure: Factory set at 0.12 in WG, minimum.
   3. Indoor Mounted Air-Cooled Units: External static pressure field set at 0.32 in WG, minimum; provide for mounting of field-installed ducts.
   4. Fan Airflow: As indicated for specific equipment.
   5. Fan Motors: Factory installed; permanently lubricated bearings; inherent protection; fan guard; output as indicated for specific equipment.

D. Condenser Coils: Copper tubes expanded into aluminum fins to form mechanical bond; waffle louver fin and rifled bore tube design to ensure high efficiency performance.

E. Compressors: Scroll type, hermetically sealed, variable speed inverter-driven and fixed speed in combination to suit total capacity; minimum of one variable speed, inverter driven compressor per condenser unit; minimum of two compressors per condenser unit; capable of controlling capacity within range of 6 percent to 100 percent of total capacity.
   1. Multiple Condenser Modules: Balance total operation hours of compressors by means of duty cycling function, providing for sequential starting of each module at each start/stop cycle, completion of oil return, and completion of defrost, or every 8 hours. Provide twinning kits where required.
   2. Failure Mode: In the event of compressor failure, operate remaining compressor(s) at proportionally reduced capacity; provide microprocessor and associated controls specifically designed to address this condition.
   3. Provide each compressor with crankcase heater, high pressure safety switch, and internal thermal overload protector.
   4. Provide oil separators and intelligent oil management system.
   5. Provide spring mounted vibration isolators.

2.05 BRANCH SELECTOR UNITS

A. Branch Selector Units: Concealed boxes designed specifically for this type of system to control heating/cooling mode selection of downstream units; consisting of electronic expansion valves, subcooling heat exchanger, refrigerant control piping and electronics to facilitate communications between unit and main processor and between branch unit and indoor/evaporator units.
   1. Provide one electronic expansion valve for each downstream unit served, except multiple indoor/evaporator units may be connected, provided balancing joints are used in downstream piping and total capacity is within capacity range of the branch selector.
   2. When branch unit is simultaneously heating and cooling, energize subcooling heat exchanger.
   3. Casing: Galvanized steel sheet; with flame and heat resistant foamed polyethylene sound and thermal insulation.
   5. Condensate Drainage: Provide condensate drain tap where required.

2.06 INDOOR/EVAPORATOR UNITS

A. All Indoor/Evaporator Units: Factory assembled and tested DX fan-coil units, with electronic proportional expansion valve, control circuit board, factory wiring and piping, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.
1. Refrigerant: Refrigerant circuits factory-charged with dehydrated air, for field charging.
2. Temperature Control Mechanism: Return air thermistor and computerized Proportional-Integral-Derivative (PID) control of superheat.
4. Coils: Direct expansion type constructed from copper tubes expanded into aluminum fins to form a mechanical bond; waffle louver fin and high heat exchange, rifled bore tube design; factory tested.
   a. Provide thermistor on liquid and gas lines.
5. Fans: Direct-drive, with statically and dynamically balanced impellers; high and low speeds unless otherwise indicated; motor thermally protected.
6. Return Air Filter: High efficiency, MERV 13
7. Condensate Drainage: Built-in condensate drain pan with PVC drain connection.
8. Cabinet Insulation: Sound absorbing foamed polystyrene and polyethylene insulation.

B. Recessed Ceiling Units: Four-way airflow cassette with central return air grille, for installation in a fixed ceiling.
   1. Cabinet Height: Maximum of 10 inches above face of ceiling.
   2. Exposed Housing: White, impact resistant, with washable decoration panel.
   3. Supply Airflow Adjustment:
      a. Via motorized louver which can be horizontally and vertically adjusted from 0 to 90 degrees.
      b. Field-modifiable to 3-way and 2-way airflow.
      c. Three auto-swing positions, including standard, draft prevention and ceiling stain prevention.
   5. Minimum Capacity: As indicated on drawings.
   6. Sound Pressure Range: Between 28 dB(A) to 33 dB(A) at low speed measured at 5 feet below the unit.
   7. Fan: Direct-drive turbo type, with motor output range of 0.06 to 0.12 HP.
   9. Provide side-mounted fresh air intake duct connection.

C. Concealed-In-Ceiling Units: Ducted horizontal discharge and return; galvanized steel cabinet.
   2. Sound Pressure: Measured at low speed at 5 feet below unit.
   3. Provide external static pressure switch adjustable for high efficiency filter operation
   5. Switch box accessible from side or bottom.

D. Wall Surface-Mounted Units: Finished white casing, with removable front grille; foamed polystyrene and polyethylene sound insulation; wall mounting plate; polystyrene condensate drain pan.
   1. Airflow Control: Auto-swing louver that closes automatically when unit stops; five (5) steps of discharge angle, set using remote controller; upon restart, discharge angle defaulting to same angle as previous operation.
   2. Sound Pressure Range: Measured at low speed at 3.3 feet below and away from unit.
   3. Condensate Drain Connection: Side (end), not concealed in wall.
   4. Fan: Direct-drive cross-flow type.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that required electrical services have been installed and are in the proper locations prior to starting installation.
B. Verify that condensate piping has been installed and is in the proper location prior to starting installation.
C. Notify Architect if conditions for installation are unsatisfactory.

3.02 INSTALLATION
A. Install in accordance with manufacturer's instructions.
B. Install refrigerant piping in accordance with equipment manufacturer's instructions.
C. Perform wiring in accordance with NFPA 70, National Electric Code (NEC).
D. Coordinate with installers of systems and equipment connecting to this system.

3.03 FIELD QUALITY CONTROL
A. Provide manufacturer's field representative to inspect installation prior to startup.

3.04 SYSTEM STARTUP
A. Provide manufacturer's field representative to perform system startup.
B. Prepare and start equipment and system in accordance with manufacturer's instructions and recommendations.
C. Adjust equipment for proper operation within manufacturer's published tolerances.

3.05 CLEANING
A. Clean exposed components of dirt, finger marks, and other disfigurements.

3.06 CLOSEOUT ACTIVITIES
A. Demonstrate proper operation of equipment to Owner's designated representative.
B. Demonstration: Demonstrate operation of system to Owner's personnel.
   1. Use operation and maintenance data as reference during demonstration.
   2. Briefly describe function, operation, and maintenance of each component.
C. Training: Train Owner's personnel on operation and maintenance of system.
   1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
   2. Provide minimum of two hours of training.
   3. Instructor: Manufacturer's training personnel.
   4. Location: At project site.

3.07 PROTECTION
A. Protect installed components from subsequent construction operations.
B. Replace exposed components broken or otherwise damaged beyond repair.

3.08 MAINTENANCE
A. See Section 01 70 00 - Execution Requirements, for additional requirements relating to maintenance service.

END OF SECTION
SECTION 26 05 01
MINOR ELECTRICAL DEMOLITION

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Electrical demolition.

1.02 RELATED REQUIREMENTS
   A. Section 01 70 00 - Execution and Closeout Requirements: Additional requirements for alterations work.

PART 2 PRODUCTS
2.01 MATERIALS AND EQUIPMENT
   A. Materials and equipment for patching and extending work: As specified in individual sections.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify field measurements and circuiting arrangements are as shown on Drawings.
   B. Verify that abandoned wiring and equipment serve only abandoned facilities.
   C. Demolition drawings are based on casual field observation.
   D. Report discrepancies to Owner before disturbing existing installation.
   E. Report discrepancies to Architect before disturbing existing installation.
   F. Beginning of demolition means installer accepts existing conditions.

3.02 PREPARATION
   A. Disconnect electrical systems in walls, floors, and ceilings to be removed.
   B. Coordinate utility service outages with utility company.
   C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations.
   D. Existing Electrical Service: Maintain existing system in service until new system is complete and ready for service. Disable system only to make switchovers and connections. Minimize outage duration.
      1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
      2. Make temporary connections to maintain service in areas adjacent to work area.
   E. Existing Fire Alarm System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
      1. Notify Owner before partially or completely disabling system.
      2. Notify local fire service.
      3. Make notifications at least 24 hours in advance.
      4. Make temporary connections to maintain service in areas adjacent to work area.
   F. Existing Security System: Maintain existing system in service until new system is accepted. Disable system only to make switchovers and connections. Minimize outage duration.
      1. Obtain permission from Owner at least 24 hours before partially or completely disabling system.
      2. Obtain permission from at least 24 hours before partially or completely disabling system.
      3. Make temporary connections to maintain service in areas adjacent to work area.
3.03 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK
A. Remove, relocate, and extend existing installations to accommodate new construction.
B. Remove abandoned wiring to source of supply.
C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling finishes. Cut conduit flush with walls and floors, and patch surfaces.
D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
E. Disconnect and remove abandoned panelboards and distribution equipment.
F. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
G. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories.
H. Repair adjacent construction and finishes damaged during demolition and extension work.
I. Maintain access to existing electrical installations that remain active. Modify installation or provide access panel as appropriate.
J. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified.

3.04 CLEANING AND REPAIR
A. Clean and repair existing materials and equipment that remain or that are to be reused.
B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
C. Luminaires: Remove existing luminaires for cleaning. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts and broken electrical parts.
D. Any lighting or ceiling-mounted devices removed during construction must be reinstalled.

END OF SECTION
SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Single conductor building wire.
B. Underground feeder and branch-circuit cable.
C. Service entrance cable.
D. Armored cable.
E. Metal-clad cable.
F. Wiring connectors.
G. Electrical tape.
H. Heat shrink tubing.
I. Oxide inhibiting compound.
J. Wire pulling lubricant.
K. Cable ties.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 26 05 01 - Minor Electrical Demolition: Disconnection, removal, and/or extension of existing electrical conductors and cables.
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
E. Section 28 46 00 - Fire Detection and Alarm: Fire alarm system conductors and cables.
F. Section 31 23 16 - Excavation.
H. Section 31 23 23 - Fill: Bedding and backfilling.

1.03 REFERENCE STANDARDS
A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire.
G. NECA 1 - Standard for Good Workmanship in Electrical Construction.
H. NECA 120 - Standard for Installing Armored Cable (AC) and Type Metal-Clad (MC) Cable.
I. NECA 121 - Standard for Installing Nonmetallic-Sheathed Cable (Type NM-B) and Underground Feeder and Branch-Circuit Cable (Type UF).


L. NFPA 70 - National Electrical Code.

M. UL 4 - Armored Cable.

N. UL 44 - Thermoset-Insulated Wires and Cables.

O. UL 83 - Thermoplastic-Insulated Wires and Cables.

P. UL 486A-486B - Wire Connectors.

Q. UL 486C - Splicing Wire Connectors.

R. UL 486D - Sealed Wire Connector Systems.

S. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables.

T. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.

U. UL 1569 - Metal-Clad Cables.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.

C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.

D. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.

E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

F. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.

B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.

1.08 FIELD CONDITIONS

A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

PART 2 PRODUCTS

2.01 CONDUCTOR AND CABLE APPLICATIONS

A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.

B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.

2.02 CONDUCTOR AND CABLE GENERAL REQUIREMENTS

A. Provide products that comply with requirements of NFPA 70.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.

D. Comply with NEMA WC 70.

E. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.

F. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

G. Conductors for Grounding and Bonding: Also comply with Section 26 05 26.

H. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.

I. Conductor Material:
   1. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B 787M unless otherwise indicated.
   2. Tinned Copper Conductors: Comply with ASTM B33.

J. Minimum Conductor Size:
   1. Branch Circuits: 12 AWG.
      a. Exceptions:
         1) 20 A, 120 V circuits longer than 75 feet: 10 AWG, for voltage drop.
         2) 20 A, 120 V circuits longer than 150 feet: 8 AWG, for voltage drop.
         3) 20 A, 277 V circuits longer than 150 feet: 10 AWG, for voltage drop.
   2. Control Circuits: 14 AWG.

K. Conductor Color Coding:
1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.

2. Color Coding Method: Integrally colored insulation.
   a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.

3. Color Code:
   a. 480Y/277 V, 3 Phase, 4 Wire System:
      1) Phase A: Brown.
      2) Phase B: Orange.
      3) Phase C: Yellow.
      4) Neutral/Grounded: Gray.
   b. 208Y/120 V, 3 Phase, 4 Wire System:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
      4) Neutral/Grounded: White.
   c. Equipment Ground, All Systems: Green.
   d. Isolated Ground, All Systems: Green with yellow stripe.
   e. Travelers for 3-Way and 4-Way Switching: Pink.
   f. For control circuits, comply with manufacturer’s recommended color code.

2.03 SINGLE CONDUCTOR BUILDING WIRE

A. Manufacturers:
   1. Copper Building Wire:
      c. Houston Wire & Cable co.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Single conductor insulated wire.

C. Conductor Stranding:
   1. Feeders and Branch Circuits:
      b. Size 8 AWG and Larger: Stranded.
   2. Control Circuits: Stranded.

D. Insulation Voltage Rating: 600 V.

E. Insulation:
   1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
      a. Size 4 AWG and Larger: Type XHHW-2.
      b. Fixture Wiring Within Luminaires: Type TFFN/TFN for luminaires with labeled maximum temperature of 90 degrees C; Approved suitable type for luminaires with labeled maximum temperature greater than 90 degrees C.

2.04 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

A. Manufacturers:
   3. Houston Wire & Cable co.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type UF multiple-conductor cable listed and labeled as complying with UL 493, Type UF-B.
C. Provide equipment grounding conductor unless otherwise indicated.

D. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.

E. Insulation Voltage Rating: 600 V.

2.05 SERVICE ENTRANCE CABLE
A. Conductor Stranding: Stranded.
B. Insulation Voltage Rating: 600 V.

2.06 ARMORED CABLE
A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Description: NFPA 70, Type AC cable listed and labeled as complying with UL 4, and listed for use in classified firestop systems to be used.
C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.
D. Insulation Voltage Rating: 600 V.
E. Insulation: Type THHN.
F. Grounding: Combination of interlocking armor and integral bonding wire.
   1. Provide additional full-size integral insulated equipment grounding conductor for redundant grounding, suitable for general purpose, non-essential electrical systems in non-hazardous patient care areas of health care facilities.
G. Armor: Steel, interlocked tape.

2.07 METAL-CLAD CABLE
A. Manufacturers:
   1. AFC Cable Systems Inc: www.afcweb.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.
C. Conductor Stranding:
   2. Size 8 AWG and Larger: Stranded.
D. Insulation Voltage Rating: 600 V.
E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
F. Provide dedicated neutral conductor for each phase conductor where indicated or required.
G. Grounding: Full-size integral equipment grounding conductor.
   1. Provide additional isolated/insulated grounding conductor where indicated or required.
H. Armor: Steel, interlocked tape.
I. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.

2.08 WIRING CONNECTORS

A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.

B. Connectors for Grounding and Bonding: Comply with Section 26 05 26.

C. Wiring Connectors for Splices and Taps:
   1. Copper Conductors Sizes 10 and under: Use twist-on insulated spring connectors.
   2. Copper Conductors Sizes 8 and larger: Use mechanical connectors.

D. Wiring Connectors for Terminations:
   1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
   2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
   3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.
   4. Conductors for Control Circuits: Use crimped terminals for all connections.

E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.

F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.

G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      c. NSI Industries LLC: www.nsiindustries.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

H. Mechanical Connectors: Provide bolted type or set-screw type.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

I. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.09 WIRING ACCESSORIES

A. Electrical Tape:
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.

2. Vinyl Color Coding Electrical Tape: Integranly colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F.
   a. Product: 3 M.
   b. Substitutions: See Section 01 60 00 - Product Requirements.

3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
   a. Product: 3 M.
   b. Substitutions: See Section 01 60 00 - Product Requirements.

4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.

5. Electrical Filler Tape: Rubber-based insulating moldable putty, minimum thickness of 125 mil; suitable for continuous temperature environment up to 176 degrees F.

6. Varnished Cambic Electrical Tape: Cotton cambic fabric tape, with or without adhesive, oil-primed and coated with high-grade insulating varnish; minimum thickness of 7 mil; suitable for continuous temperature environment up to 221 degrees F.

7. Moisture Sealing Electrical Tape: Insulating mastic compound laminated to flexible, all-weather vinyl backing; minimum thickness of 90 mil.

B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
   1. Manufacturers:
      a. 3M: www.3m.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.

E. Cable Ties: Material and tensile strength rating suitable for application.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that interior of building has been protected from weather.

B. Verify that work likely to damage wire and cable has been completed.
C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
D. Verify that field measurements are as shown on the drawings.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

3.03 INSTALLATION
A. Circuiting Requirements:
   1. Unless dimensioned, circuit routing indicated is diagrammatic.
   2. When circuit destination is indicated and routing is not shown, determine exact routing required.
   3. Arrange circuiting to minimize splices.
   4. Include circuit lengths required to install connected devices within 10 ft of location shown.
   5. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
   6. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
   7. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted.
B. Install products in accordance with manufacturer's instructions.
C. Install conductors and cable in a neat and workmanlike manner in accordance with NECA 1.
D. Install underground feeder and branch-circuit cable (Type UF-B) in accordance with NECA 121.
E. Install armored cable (Type AC) in accordance with NECA 120.
F. Install metal-clad cable (Type MC) in accordance with NECA 120.
G. Installation in Raceway:
   1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
   2. Pull all conductors and cables together into raceway at same time.
   3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
   4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
H. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
I. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
J. Terminate cables using suitable fittings.
   1. Armored Cable (Type AC):
      a. Use listed fittings and anti-short, insulating bushings.
      b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
   2. Metal-Clad Cable (Type MC):
      a. Use listed fittings.
b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.

K. Install conductors with a minimum of 12 inches of slack at each outlet.

L. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.

M. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

N. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.

O. Make wiring connections using specified wiring connectors.
   1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
   2. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors.
   3. Do not remove conductor strands to facilitate insertion into connector.
   4. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
   5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
   6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

P. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
   1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
      b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
   2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
      a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
      b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.

Q. Insulate ends of spare conductors using vinyl insulating electrical tape.

R. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.

S. Identify conductors and cables in accordance with Section 26 05 53.

T. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

U. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect and test in accordance with NETA ATS, except Section 4.

C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.

D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION
PART 1  GENERAL

1.01  SECTION INCLUDES

A. Grounding and bonding requirements.
B. Conductors for grounding and bonding.
C. Connectors for grounding and bonding.
D. Ground bars.
E. Ground rod electrodes.
F. Ground enhancement material.
G. Ground access wells.
H. Grounding and bonding components.
I. Provide all components necessary to complete the grounding system(s) consisting of:
   1. Existing metal underground water pipe.
   2. Metal frame of the building.
   3. Existing metal underground gas piping system.
   4. Metal underground gas piping system.

1.02  RELATED REQUIREMENTS

A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
C. Section 26 56 00 - Exterior Lighting: Additional grounding and bonding requirements for pole-mounted luminaires.

1.03  REFERENCE STANDARDS

B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
F. NFPA 70 - National Electrical Code.
G. UL 467 - Grounding and Bonding Equipment.

1.04  ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Verify exact locations of underground metal water service pipe entrances to building.
   2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Sequencing:
1. Do not install ground rod electrodes until final backfill and compaction is complete.

1.05 PERFORMANCE REQUIREMENTS
   A. Grounding System Resistance: 25 ohms.

1.06 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
   B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
   C. Shop Drawings:
   D. Product Data: Provide for grounding electrodes and connections.
   E. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
   F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
   G. Project Record Documents: Record actual locations of grounding electrode system components and connections.
   H. Project Record Documents: Record actual locations of components and grounding electrodes.

1.07 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.
   B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
   C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
   D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.
   E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.08 DELIVERY, STORAGE, AND HANDLING
   A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 GROUNDING AND BONDING REQUIREMENTS
   A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
   B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
   C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
   D. Grounding System Resistance:
      1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
      2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.
3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.

E. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
   a. Provide continuous grounding electrode conductors without splice or joint.
   b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
2. Metal Underground Water Pipe(s):
   a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
   b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
   c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
3. Metal Building or Structure Frame:
   a. Provide connection to metal building or structure frame effectively grounded in accordance with NFPA 70 at nearest accessible location.
4. Ground Ring:
   a. Provide a ground ring encircling the building or structure consisting of bare copper conductor not less than 2 AWG in direct contact with earth, installed at a depth of not less than 30 inches.
   b. Where location is not indicated, locate ground ring conductor at least 24 inches outside building perimeter foundation.
   c. Provide ground enhancement material around conductor where indicated.
   d. Provide connection from ground ring conductor to:
      1) Perimeter columns of metal building frame.
      2) Ground rod electrodes located as indicated.
5. Ground Rod Electrode(s):
   a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
   b. Space electrodes not less than 10 feet from each other and any other ground electrode.
   c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
   d. Provide ground access well for each electrode.
6. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

F. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
G. Bonding and Equipment Grounding:
   1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
   2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
   3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
   4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
   6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
   7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
      a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
      b. Metal gas piping.
   8. Provide bonding for interior metal air ducts.
   9. Provide bonding for metal building frame where not used as a grounding electrode.

H. Isolated Ground System:
   1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
   2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
   3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.

I. Pole-Mounted Luminaires: Also comply with Section 26 56 00.

2.02 GROUNDING AND BONDING COMPONENTS

A. General Requirements:
   1. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
   2. Provide products listed and labeled as complying with UL 467 where applicable.

B. Conductors for Grounding and Bonding, in addition to requirements of Section 26 05 19:
   1. Use insulated copper conductors unless otherwise indicated.
      a. Exceptions:
         1) Use bare copper conductors where installed underground in direct contact with earth.
         2) Use bare copper conductors where directly encased in concrete (not in raceway).

C. Connectors for Grounding and Bonding:
   1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
   a. Exceptions:
      1) Use mechanical connectors for connections to electrodes at ground access wells.

3. Unless otherwise indicated, use exothermic welded connections for accessible connections.
   a. Exceptions:
      1) Use exothermic welded connections for connections to metal building frame.

4. Manufacturers - Mechanical and Compression Connectors:
   d. Substitutions: See Section 01 60 00 - Product Requirements.

5. Manufacturers - Exothermic Welded Connections:
   d. Substitutions: See Section 01 60 00 - Product Requirements.

D. Ground Bars:
   1. Description: Copper rectangular ground bars with mounting brackets and insulators.
   2. Size: As indicated.
   3. Holes for Connections: As indicated or as required for connections to be made.

4. Manufacturers:
   e. Substitutions: See Section 01 60 00 - Product Requirements.

E. Ground Rod Electrodes:
   1. Comply with NEMA GR 1.
   3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

4. Manufacturers:
   e. Substitutions: See Section 01 60 00 - Product Requirements.

F. Ground Enhancement Material:
   1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
   2. Resistivity: Not more than 20 ohm-cm in final installed form.

3. Manufacturers:
   d. Substitutions: See Section 01 60 00 - Product Requirements.

G. Ground Access Wells:
1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.

2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
   a. Round Wells: Not less than 8 inches in diameter.

3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 10 inches.

4. Cover: Factory-identified by permanent means with word "GROUND".

5. Manufacturers:
   e. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 MANUFACTURERS
   D. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 CONNECTORS AND ACCESSORIES
   A. Mechanical Connectors: Bronze.
      1. Substitutions: See Section 01 60 00 - Product Requirements.
   B. Wire: Stranded copper.
   C. Grounding Electrode Conductor: Size to meet NFPA 70 requirements.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that work likely to damage grounding and bonding system components has been completed.
   B. Verify that field measurements are as shown on the drawings.
   C. Verify that conditions are satisfactory for installation prior to starting work.
   D. Verify existing conditions prior to beginning work.
   E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.02 INSTALLATION
   A. Install products in accordance with manufacturer's instructions.
   B. Install grounding and bonding system components in a neat and workmanlike manner in accordance with NECA 1.
   C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches (750 mm) deep in accordance with NFPA 70 or provide ground plates.
      1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
   D. Make grounding and bonding connections using specified connectors.
1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.

E. Identify grounding and bonding system components in accordance with Section 26 05 53.
F. Provide bonding to meet requirements described in Quality Assurance.
G. Equipment Grounding Conductor: Provide separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing. Each of branch circuits and feeder circuits shall have dedicated equipment grounding conductor, sharing this conductor with other grounding conductors is not permitted.

3.03 FIELD QUALITY CONTROL
A. Perform inspection in accordance with Section 01 40 00.
B. Inspect and test in accordance with NETA STD ATS except Section 4.
C. Perform inspections and tests listed in NETA STD ATS, Section 7.13.
D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.

END OF SECTION
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SECTION 26 05 29
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Support and attachment components for equipment, conduit, cable, boxes, and other electrical work.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 05 50 00 - Metal Fabrications: Materials and requirements for fabricated metal supports.
C. Section 26 05 34 - Conduit: Additional support and attachment requirements for conduits.
D. Section 26 05 37 - Boxes: Additional support and attachment requirements for boxes.
E. Section 26 51 00 - Interior Lighting: Additional support and attachment requirements for interior luminaires.
F. Section 26 56 00 - Exterior Lighting: Additional support and attachment requirements for exterior luminaires.

1.03 REFERENCE STANDARDS
D. MFMA-4 - Metal Framing Standards Publication.
E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
F. NFPA 70 - National Electrical Code.
G. UL 5B - Strut-Type Channel Raceways and Fittings.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
   2. Coordinate the work with other trades to provide additional framing and materials required for installation.
   3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
   4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 30 00.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.

C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

D. Installer's Qualifications: Include evidence of compliance with specified requirements.

E. Product Data: Provide manufacturer's catalog data for fastening systems.

F. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.06 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Comply with applicable building code.

C. Maintain at the project site a copy of each referenced document that prescribes execution requirements.

D. Installer Qualifications for Powder-Actuated Fasteners (when specified): Certified by fastener system manufacturer with current operator's license.

E. Installer Qualifications for Field-Welding: As specified in Section 05 50 00.

F. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

A. General Requirements:
   1. Comply with the following. Where requirements differ, comply with most stringent.
      a. NFPA 70.
      b. Requirements of authorities having jurisdiction.
   2. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
   3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated, where applicable.
   4. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 1.5. Include consideration for vibration, equipment operation, and shock loads where applicable.
   5. Do not use products for applications other than as permitted by NFPA 70 and product listing.
      a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.

B. Materials for Metal Fabricated Supports: Comply with Section 05 50 00.

C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
   1. Conduit Straps: One-hole or two-hole type; steel or malleable iron.
   2. Conduit Clamps: Bolted type unless otherwise indicated.
   3. Manufacturers:
      e. Substitutions: See Section 01 60 00 - Product Requirements.

D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
   1. Manufacturers:
      e. Substitutions: See Section 01 60 00 - Product Requirements.

E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
   2. Channel (Strut) Used as Raceway (only where specifically indicated): Listed and labeled as complying with UL 5B.
   3. Channel Material:
      a. Indoor Dry Locations: Use painted steel, zinc-plated steel, or galvanized steel.
      b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
   4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
   6. Manufacturers:
      c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
      d. Substitutions: See Section 01 60 00 - Product Requirements.
      e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.

F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
   1. Minimum Size, Unless Otherwise Indicated or Required:
      a. Equipment Supports: 1/2 inch diameter.
      b. Single Conduit up to 1 inch (27mm) trade size: 1/4 inch diameter.
      c. Single Conduit larger than 1 inch (27mm) trade size: 3/8 inch diameter.
      d. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
e. Outlet Boxes: 1/4 inch diameter.
f. Luminaires: 1/4 inch diameter.

G. Anchors and Fasteners:
1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
7. Sheet Metal: Use sheet metal screws.
8. Powder-actuated fasteners are not permitted.
9. Hammer-driven anchors and fasteners are not permitted.
10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
   b. Channel Material: Use galvanized steel.
   c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

2.02 MANUFACTURERS
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 MATERIALS
A. Hangers, Supports, Anchors, and Fasteners - General: Corrosion-resistant materials of size and type adequate to carry the loads of equipment and conduit, including weight of wire in conduit.
B. Supports: Fabricated of structural steel or formed steel members; galvanized.
C. Anchors and Fasteners:
   1. Do not use powder-actuated anchors.
   2. Obtain permission from Architect before using powder-actuated anchors.
   3. Concrete Structural Elements: Use precast inserts.
   4. Steel Structural Elements: Use beam clamps.
   5. Concrete Surfaces: Use self-drilling anchors or expansion anchors.
   7. Solid Masonry Walls: Use expansion anchors.
D. Formed Steel Channel:
   1. Product: manufactured by [B-Line].
   2. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION
3.01 EXAMINATION
A. Verify that field measurements are as shown on the drawings.
B. Verify that mounting surfaces are ready to receive support and attachment components.
C. Verify that conditions are satisfactory for installation prior to starting work.
3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install support and attachment components in a neat and workmanlike manner in accordance with NECA 1.
C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
D. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
E. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.

G. Equipment Support and Attachment:
   1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
   2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
   3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
   4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

H. Conduit Support and Attachment: Also comply with Section 26 05 34.
I. Box Support and Attachment: Also comply with Section 26 05 37.
J. Interior Luminaire Support and Attachment: Also comply with Section 26 51 00.
K. Exterior Luminaire Support and Attachment: Also comply with Section 26 56 00.
L. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
M. Secure fasteners according to manufacturer's recommended torque settings.
N. Remove temporary supports.
O. Identify independent electrical component support wires above accessible ceilings (only where specifically indicated or permitted) with color distinguishable from ceiling support wires in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect support and attachment components for damage and defects.
C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION
SECTION 26 05 34
CONDUIT

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Galvanized steel rigid metal conduit (RMC).
   B. Flexible metal conduit (FMC).
   C. Liquidtight flexible metal conduit (LFMC).
   D. Electrical metallic tubing (EMT).
   E. Rigid polyvinyl chloride (PVC) conduit.
   F. Conduit fittings.
   G. Accessories.
   H. Conduit, fittings and conduit bodies.

1.02 RELATED REQUIREMENTS
   A. Section 03 30 00 - Cast-in-Place Concrete: Concrete encasement of conduits.
   B. Section 07 84 00 - Firestopping.
   C. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Metal clad cable (Type MC), armored cable (Type AC), and manufactured wiring systems, including uses permitted.
   D. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   E. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   F. Section 26 0553 - Identification for Electrical Systems.
   G. Section 26 05 37 - Boxes.
   H. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   I. Section 31 23 16 - Excavation.

1.03 REFERENCE STANDARDS
   A. ANSI C80.1 - American National Standard for Electrical Rigid Steel Conduit (ERSC).
   B. ANSI C80.3 - American National Standard for Electrical Metallic Tubing -- Steel (EMT-S).
   C. ANSI C80.5 - American National Standard for Electrical Rigid Metal Conduit -- Aluminum (ERMC-A).
   D. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   E. NECA 101 - Standard for Installing Steel Conduits (Rigid, IMC, EMT).
   F. NECA 111 - Standard for Installing Nonmetallic Raceways (RNC, ENT, LFNC).
   G. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
   H. NFPA 70 - National Electrical Code.
   I. UL 1 - Flexible Metal Conduit.
   J. UL 6 - Electrical Rigid Metal Conduit-Steel.
   K. UL 360 - Liquid-Tight Flexible Metal Conduit.
L. UL 514B - Conduit, Tubing, and Cable Fittings.
M. UL 651 - Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
N. UL 797 - Electrical Metallic Tubing-Steel.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate minimum sizes of conduits with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
   2. Coordinate the arrangement of conduits with structural members, ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
   3. Verify exact conduit termination locations required for boxes, enclosures, and equipment installed under other sections or by others.
   4. Coordinate the work with other trades to provide roof penetrations that preserve the integrity of the roofing system and do not void the roof warranty.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
B. Sequencing:
   1. Do not begin installation of conductors and cables until installation of conduit is complete between outlet, junction and splicing points.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for conduits and fittings.
C. Shop Drawings:
   1. Indicate proposed arrangement for conduits to be installed within structural concrete slabs, where permitted.
   2. Include proposed locations of roof penetrations and proposed methods for sealing.
D. Project Record Documents: Record actual routing for conduits installed underground, conduits embedded within concrete slabs, and conduits 2 inch (53 mm) trade size and larger.
E. Product Data: Provide for metallic conduit and flexible metal conduit.
F. Samples of Materials Actually Delivered to Site:
   1. Two pieces each of conduit, 2 feet long.
G. Project Record Documents: Accurately record actual routing of conduits larger than 2 inches.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
D. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and shown.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store conduit and fittings in accordance with manufacturer’s instructions.
B. Accept conduit on site. Inspect for damage.

C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

D. Protect PVC conduit from sunlight.

PART 2 PRODUCTS

2.01 CONDUIT APPLICATIONS

A. Do not use conduit and associated fittings for applications other than as permitted by NFPA 70 and product listing.

B. Unless otherwise indicated and where not otherwise restricted, use the conduit types indicated for the specified applications. Where more than one listed application applies, comply with the most restrictive requirements. Where conduit type for a particular application is not specified, use galvanized steel rigid metal conduit.

C. Underground:
   1. Under Slab on Grade: Use rigid PVC conduit.
   2. Exterior, Direct-Buried: Use rigid PVC conduit.
   3. Exterior, Embedded Within Concrete: Use rigid PVC conduit.
   4. Where rigid polyvinyl (PVC) conduit is provided, transition to galvanized steel rigid metal conduit where emerging from underground.
   5. Where rigid polyvinyl (PVC) conduit larger than 2 inch (53 mm) trade size is provided, use galvanized steel rigid metal conduit elbows for bends.

D. Embedded Within Concrete:

E. Concealed Within Masonry Walls: Use galvanized steel rigid metal conduit.

F. Concealed Within Hollow Stud Walls: Use electrical metallic tubing (EMT).

G. Concealed Above Accessible Ceilings: Use electrical metallic tubing (EMT).

H. Interior, Damp or Wet Locations: Use galvanized steel rigid metal conduit.

I. Exposed, Interior, Not Subject to Physical Damage: Use galvanized steel rigid metal conduit.

J. Exposed, Interior, Subject to Physical Damage: Use galvanized steel rigid metal conduit.
   1. Locations subject to physical damage include, but are not limited to:
      a. Where exposed below 8 feet, except within electrical and communication rooms or closets.


L. Concealed, Exterior, Not Embedded in Concrete or in Contact With Earth: Use galvanized steel rigid metal conduit.

M. Connections to Luminaires Above Accessible Ceilings: Use flexible metal conduit.
   1. Maximum Length: 6 feet.

N. Connections to Vibrating Equipment:
   1. Dry Locations: Use flexible metal conduit.
   2. Damp, Wet, or Corrosive Locations: Use liquidtight flexible metal conduit.
   3. Maximum Length: 6 feet unless otherwise indicated.
   4. Vibrating equipment includes, but is not limited to:
      a. Transformers.
      b. Motors.
      c. HVAC equipment.

O. Fished in Existing Walls, Where Necessary: Use flexible metal conduit.
2.02 CONDUIT REQUIREMENTS

A. Provide all conduit, fittings, supports, and accessories required for a complete raceway system.

B. Provide products listed, classified, and labeled by Underwriter’s Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

C. Minimum Conduit Size, Unless Otherwise Indicated:
   1. Branch Circuits: 3/4 inch (21 mm) trade size.
   2. Branch Circuit Homeruns: 3/4 inch (21 mm) trade size.
   3. Control Circuits: 1/2 inch (16 mm) trade size.
   4. Flexible Connections to Luminaires: 1/2 inch (16 mm) trade size.
   5. Underground, Interior: 3/4 inch (21 mm) trade size.
   6. Underground, Exterior: 1 inch (27 mm) trade size.

D. Where conduit size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

2.03 GALVANIZED STEEL RIGID METAL CONDUIT (RMC)

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type RMC galvanized steel rigid metal conduit complying with ANSI C80.1 and listed and labeled as complying with UL 6.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

2.04 METAL CONDUIT

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Rigid Steel Conduit: ANSI C80.1.

C. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.05 FLEXIBLE METAL CONDUIT (FMC)

A. Manufacturers:
   1. AFC Cable Systems, Inc: www.afcweb.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type FMC standard wall steel flexible metal conduit listed and labeled as complying with UL 1, and listed for use in classified firestop systems to be used.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

   3. Material: Use steel or malleable iron.

D. Description: Interlocked steel construction.

E. Fittings: NEMA FB 1.

2.06 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (LFMC)

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type LFMC polyvinyl chloride (PVC) jacketed steel flexible metal conduit listed and labeled as complying with UL 360.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.

   2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.

   3. Material: Use steel or malleable iron.

2.07 ELECTRICAL METALLIC TUBING (EMT)

A. Manufacturers:
   3. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type EMT steel electrical metallic tubing complying with ANSI C80.3 and listed and labeled as complying with UL 797.

C. Fittings:
   1. Manufacturers:
      d. Substitutions: See Section 01 60 00 - Product Requirements.
2. Description: Fittings complying with NEMA FB 1 and listed and labeled as complying with UL 514B.
3. Material: Use steel or malleable iron.
4. Connectors and Couplings: Use compression (gland) or set-screw type.
   a. Do not use indenter type connectors and couplings.
5. Damp or Wet Locations (where permitted): Use fittings listed for use in wet locations.
6. Embedded Within Concrete (where permitted): Use fittings listed as concrete-tight. Fittings that require taping to be concrete-tight are acceptable.

2.08 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: NFPA 70, Type PVC rigid polyvinyl chloride conduit complying with NEMA TC 2 and listed and labeled as complying with UL 651; Schedule 40 unless otherwise indicated, Schedule 80 where subject to physical damage; rated for use with conductors rated 90 degrees C.

C. Fittings:
   1. Manufacturer: Same as manufacturer of conduit to be connected.
   2. Description: Fittings complying with NEMA TC 3 and listed and labeled as complying with UL 651; material to match conduit.

2.09 ACCESSORIES

A. Conduit Joint Compound: Corrosion-resistant, electrically conductive; suitable for use with the conduit to be installed.
B. Solvent Cement for PVC Conduit and Fittings: As recommended by manufacturer of conduit and fittings to be installed.
C. Pull Strings: Use nylon cord with average breaking strength of not less than 200 pound-force.
D. Sealing Compound for Sealing Fittings: Listed for use with the particular fittings to be installed.
E. Modular Seals for Conduit Penetrations: Rated for minimum of 40 psig; Suitable for the conduits to be installed.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on drawings.
B. Verify that mounting surfaces are ready to receive conduits.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Verify routing and termination locations of conduit prior to rough-in.
E. Conduit routing is shown on drawings in approximate locations unless dimensioned. Route as required to complete wiring system.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Install conduit in a neat and workmanlike manner in accordance with NECA 1.
C. Install galvanized steel rigid metal conduit (RMC) in accordance with NECA 101.
D. Install rigid polyvinyl chloride (PVC) conduit in accordance with NECA 111.
E. Conduit Routing:
1. Unless dimensioned, conduit routing indicated is diagrammatic.
2. When conduit destination is indicated and routing is not shown, determine exact routing required.
3. Conceal all conduits unless specifically indicated to be exposed.
4. Conduits in the following areas may be exposed, unless otherwise indicated:
   a. Electrical rooms.
   b. Mechanical equipment rooms.
   c. Within joists in areas with no ceiling.
5. Arrange conduit to maintain adequate headroom, clearances, and access.
6. Arrange conduit to provide no more than the equivalent of four 90 degree bends between pull points.
7. Arrange conduit to provide no more than 150 feet between pull points.
8. Arrange conduit to prevent moisture traps. Provide drain fittings at low points and at sealing fittings where moisture may collect.
9. Maintain minimum clearance of 6 inches between conduits and piping for other systems.
10. Maintain minimum clearance of 12 inches between conduits and hot surfaces. This includes, but is not limited to:
    a. Heaters.
    b. Hot water piping.
    c. Flues.
11. Group parallel conduits in the same area together on a common rack.

F. Conduit Support:
1. Secure and support conduits in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
2. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
3. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conduits to lay on ceiling tiles.
4. Use conduit strap to support single surface-mounted conduit.
   a. Use clamp back spacer with conduit strap for damp and wet locations to provide space between conduit and mounting surface.
5. Use metal channel (strut) with accessory conduit clamps to support multiple parallel surface-mounted conduits.
6. Use conduit clamp to support single conduit from beam clamp or threaded rod.
7. Use trapeze hangers assembled from threaded rods and metal channel (strut) with accessory conduit clamps to support multiple parallel suspended conduits.
8. Use of spring steel conduit clips for support of conduits is not permitted.
9. Use of wire for support of conduits is not permitted.
   a. For securing conduits to studs in hollow stud walls.
   b. For suspending conduits supported by spring steel conduit clips (only where specifically indicated or permitted).

G. Connections and Terminations:
1. Use approved zinc-rich paint or conduit joint compound on field-cut threads of galvanized steel conduits prior to making connections.
2. Where two threaded conduits must be joined and neither can be rotated, use three-piece couplings or split couplings. Do not use running threads.
3. Use suitable adapters where required to transition from one type of conduit to another.
4. Provide drip loops for liquidtight flexible conduit connections to prevent drainage of liquid into connectors.
5. Terminate threaded conduits in boxes and enclosures using threaded hubs or double lock nuts for dry locations and raintight hubs for wet locations.

6. Provide insulating bushings or insulated throats at all conduit terminations to protect conductors.

7. Secure joints and connections to provide maximum mechanical strength and electrical continuity.

H. Penetrations:
   1. Do not penetrate or otherwise notch or cut structural members, including footings and grade beams, without approval of Structural Engineer.
   2. Make penetrations perpendicular to surfaces unless otherwise indicated.
   3. Provide sleeves for penetrations as indicated or as required to facilitate installation. Set sleeves flush with exposed surfaces unless otherwise indicated or required.
   4. Conceal bends for conduit risers emerging above ground.
   5. Seal interior of conduits entering the building from underground at first accessible point to prevent entry of moisture and gases.
   6. Where conduits penetrate waterproof membrane, seal as required to maintain integrity of membrane.
   7. Make penetrations for roof-mounted equipment within associated equipment openings and curbs where possible to minimize roofing system penetrations. Where penetrations are necessary, seal as indicated or as required to preserve integrity of roofing system and maintain roof warranty. Include proposed locations of penetrations and methods for sealing with submittals.
   8. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

I. Underground Installation:
   1. Provide trenching and backfilling in accordance with Section 31 23 16.13.
   2. Minimum Cover, Unless Otherwise Indicated or Required:
      b. Under Slab on Grade: 12 inches to bottom of slab.
   3. Provide underground warning tape in accordance with Section 26 05 53 along entire conduit length.

J. Concrete Encasement: Where conduits not otherwise embedded within concrete are indicated to be concrete-encased, provide concrete in accordance with Section 03 30 00 with minimum concrete cover of 3 inches on all sides unless otherwise indicated.

K. Hazardous (Classified) Locations: Where conduits cross boundaries of hazardous (classified) locations, provide sealing fittings located as indicated or in accordance with NFPA 70.

L. Conduit Movement Provisions: Where conduits are subject to movement, provide expansion and expansion/deflection fittings to prevent damage to enclosed conductors or connected equipment. This includes, but is not limited to:
   1. Where conduits cross structural joints intended for expansion, contraction, or deflection.
   2. Where conduits are subject to earth movement by settlement or frost.

M. Conduit Sealing:
   1. Use foam conduit sealant to prevent entry of moisture and gases. This includes, but is not limited to:
      a. Where conduits enter building from outside.
      b. Where service conduits enter building from underground distribution system.
      c. Where conduits enter building from underground.
      d. Where conduits may transport moisture to contact live parts.
2. Where conduits cross barriers between areas of potential substantial temperature differential, use foam conduit sealant at accessible point near penetration to prevent condensation. This includes, but is not limited to:
   a. Where conduits pass from outdoors into conditioned interior spaces.
   b. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

N. Condensation Prevention: Where conduits cross barriers between areas of potential substantial temperature differential, provide sealing fitting or approved sealing compound at an accessible point near the penetration to prevent condensation. This includes, but is not limited to:
   1. Where conduits pass from outdoors into conditioned interior spaces.
   2. Where conduits pass from unconditioned interior spaces into conditioned interior spaces.

O. Provide pull string in all empty conduits and in conduits where conductors and cables are to be installed by others. Leave minimum slack of 12 inches at each end.

P. Provide grounding and bonding in accordance with Section 26 05 26.

Q. Identify conduits in accordance with Section 26 05 53.

3.03 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
   C. Correct deficiencies and replace damaged or defective conduits.

3.04 CLEANING
   A. Clean interior of conduits to remove moisture and foreign matter.

3.05 PROTECTION
   A. Immediately after installation of conduit, use suitable manufactured plugs to provide protection from entry of moisture and foreign material and do not remove until ready for installation of conductors.

3.06 INTERFACE WITH OTHER PRODUCTS
   A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
   B. Route conduit through roof openings for piping and ductwork wherever possible. Where separate roofing penetration is required, coordinate location and installation method with roofing installation specified in Section roofing section.

END OF SECTION
SECTION 26 05 37
BOXES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Outlet and device boxes up to 100 cubic inches, including those used as junction and pull boxes.
B. Cabinets and enclosures, including junction and pull boxes larger than 100 cubic inches.
C. Wall and ceiling outlet boxes.
D. Floor boxes.
E. Pull and junction boxes.

1.02 RELATED REQUIREMENTS
A. Section 07 84 00 - Firestopping.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 29 - Hangers and Supports for Electrical Systems.
D. Section 26 27 26 - Wiring Devices:
   1. Wall plates.
E. Section 26 2716 - Electrical Cabinets and Enclosures.
F. Section 26 2726 - Wiring Devices: Wall plates in finished areas, floor box service fittings, fire-rated poke-through fittings, and access floor boxes.

1.03 REFERENCE STANDARDS
A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
B. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
D. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
E. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports.
F. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
G. NFPA 70 - National Electrical Code.
H. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
I. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
J. UL 508A - Industrial Control Panels.
K. UL 514A - Metallic Outlet Boxes.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate minimum sizes of boxes with the actual installed arrangement of conductors, clamps, support fittings, and devices, calculated according to NFPA 70.
4. Coordinate minimum sizes of pull boxes with the actual installed arrangement of connected conduits, calculated according to NFPA 70.
5. Coordinate the placement of boxes with millwork, furniture, devices, equipment, etc. installed under other sections or by others.
6. Coordinate the work with other trades to preserve insulation integrity.
7. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted boxes where indicated.
8. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Project Record Documents: Record actual locations and mounting heights of outlet, pull, and junction boxes on project record documents.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 BOXES
A. General Requirements:
1. Do not use boxes and associated accessories for applications other than as permitted by NFPA 70 and product listing.
2. Provide all boxes, fittings, supports, and accessories required for a complete raceway system and to accommodate devices and equipment to be installed.
3. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
4. Where box size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
5. Provide grounding terminals within boxes where equipment grounding conductors terminate.
B. Outlet and Device Boxes Up to 100 cubic inches, Including Those Used as Junction and Pull Boxes:
1. Use sheet-steel boxes for dry locations unless otherwise indicated or required.
2. Use cast iron boxes or cast aluminum boxes for damp or wet locations unless otherwise indicated or required; furnish with compatible weatherproof gasketed covers.
3. Use suitable concrete type boxes where flush-mounted in concrete.
4. Use suitable masonry type boxes where flush-mounted in masonry walls.
5. Use raised covers suitable for the type of wall construction and device configuration where required.
6. Use shallow boxes where required by the type of wall construction.
7. Do not use "through-wall" boxes designed for access from both sides of wall.
8. Sheet-Steel Boxes: Comply with NEMA OS 1, and list and label as complying with UL 514A.
9. Cast Metal Boxes: Comply with NEMA FB 1, and list and label as complying with UL 514A; furnish with threaded hubs.
10. Boxes for Supporting Luminaires and Ceiling Fans: Listed as suitable for the type and weight of load to be supported; furnished with fixture stud to accommodate mounting of luminaire where required.
C. Cabinets and Enclosures, Including Junction and Pull Boxes Larger Than 100 cubic inches:
1. Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E, or UL 508A.
2. NEMA 250 Environment Type, Unless Otherwise Indicated:
3. Junction and Pull Boxes Larger Than 100 cubic inches:
   a. Provide screw-cover or hinged-cover enclosures unless otherwise indicated.

2.02 MANUFACTURERS
B. Steel City
C. Substitutions: Reco, Inc. See Section 01 60 00 - Product Requirements.

2.03 OUTLET BOXES
A. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
   1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; include 1/2 inch male fixture studs where required.
   2. Concrete Ceiling Boxes: Concrete type.
B. Nonmetallic Outlet Boxes: NEMA OS 2.
C. Cast Boxes: NEMA FB 1, Type FD, aluminum. Provide gasketed cover by box manufacturer. Provide threaded hubs.
D. Wall Plates for Finished Areas: As specified in Section 26 2726.

2.04 FLOOR BOXES
A. Floor Boxes: NEMA OS 1, fully adjustable, _4 inches deep.
B. Material: Cast metal.
C. Shape: Rectangular.
D. Service Fittings: As specified in Section 26 2726.

2.05 PULL AND JUNCTION BOXES
A. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
B. Hinged Enclosures: As specified in Section 26 2716.
C. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
   1. Material: Galvanized cast iron; Cast Aluminum.
   2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
D. In-Ground Cast Metal Box: NEMA 250, Type 6, outside flanged, recessed cover box for flush mounting:
   1. Material: Galvanized cast iron; Cast Aluminum.
   2. Cover: Nonskid cover with neoprene gasket and stainless steel cover screws.
   3. Cover Legend: "ELECTRIC".

PART 3 EXECUTION
3.01 EXAMINATION
3.02
A. Verify that field measurements are as shown on drawings.
B. Verify that mounting surfaces are ready to receive boxes.
C. Verify that conditions are satisfactory for installation prior to starting work.
D. Verify locations of floor boxes and outlets in offices and work areas prior to rough-in.

3.03 INSTALLATION

A. Install products in accordance with manufacturer's instructions.
B. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards where mounting heights are not indicated.
C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
D. Box Supports:
   1. Secure and support boxes in accordance with NFPA 70 and Section 26 05 29 using suitable supports and methods approved by the authority having jurisdiction.
   2. Provide independent support from building structure except for cast metal boxes (other than boxes used for fixture support) supported by threaded conduit connections in accordance with NFPA 70. Do not provide support from piping, ductwork, or other systems.
E. Install boxes plumb and level.
F. Flush-Mounted Boxes:
   1. Install boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that front edge of box or associated raised cover is not set back from finished surface more than 1/4 inch or does not project beyond finished surface.
   2. Install boxes in combustible materials such as wood so that front edge of box or associated raised cover is flush with finished surface.
   3. Repair rough openings around boxes in noncombustible materials such as concrete, tile, gypsum, plaster, etc. so that there are no gaps or open spaces greater than 1/8 inch at the edge of the box.
G. Install boxes as required to preserve insulation integrity.
H. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
I. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.
J. Close unused box openings.
K. Install blank wall plates on junction boxes and on outlet boxes with no devices or equipment installed or designated for future use.
L. Provide grounding and bonding in accordance with Section 26 05 26.
M. Install boxes securely, in a neat and workmanlike manner, as specified in NECA 1.
N. Install in locations as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections, and as required by NFPA 70.
O. Coordinate installation of outlet boxes for equipment connected under Section 26 2717.
P. Set wall mounted boxes at elevations to accommodate mounting heights indicated.
Q. Electrical boxes are shown on Drawings in approximate locations unless dimensioned.
   1. Adjust box locations up to 10 feet if required to accommodate intended purpose.
R. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
S. Maintain headroom and present neat mechanical appearance.
T. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
U. Inaccessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
V. Install boxes to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 8400.
W. Coordinate mounting heights and locations of outlets mounted above counters, benches, and backsplashes.
X. Locate outlet boxes to allow luminaires positioned as shown on reflected ceiling plan.
Y. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
Z. Use flush mounting outlet box in finished areas.
AA. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
AB. Do not install flush mounting box back-to-back in walls; provide minimum 6 inches separation. Provide minimum 24 inches separation in acoustic rated walls.
AC. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
AD. Use stamped steel bridges to fasten flush mounting outlet box between studs.
AE. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
AF. Use adjustable steel channel fasteners for hung ceiling outlet box.
AG. Do not fasten boxes to ceiling support wires.
AH. Support boxes independently of conduit, except cast box that is connected to two rigid metal conduits both supported within 12 inches of box.
AI. Use gang box where more than one device is mounted together. Do not use sectional box.
AJ. Use gang box with plaster ring for single device outlets.
AK. Use cast outlet box in exterior locations exposed to the weather and wet locations.
AL. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
AM. Set floor boxes level.
AN. Large Pull Boxes: Use hinged enclosure in interior dry locations, surface-mounted cast metal box in other locations.

3.04 ADJUSTING
A. Adjust floor boxes flush with finish flooring material.
B. Adjust flush-mounting outlets to make front flush with finished wall material.
C. Install knockout closures in unused box openings.

3.05 CLEANING
A. Clean interior of boxes to remove dirt, debris, plaster and other foreign material.

3.06 PROTECTION
A. Immediately after installation, protect boxes from entry of moisture and foreign material until ready for installation of conductors.

END OF SECTION
SECTION 26 05 53
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical identification requirements.
B. Identification nameplates and labels.
C. Wire and cable markers.
D. Voltage markers.
E. Warning signs and labels.
F. Field-painted identification of conduit.

1.02 RELATED REQUIREMENTS
A. Section 09 90 00 - Painting and Coating.

1.03 REFERENCE STANDARDS
C. NFPA 70 - National Electrical Code.
D. UL 969 - Marking and Labeling Systems.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements for submittals procedures.
B. Product Data: Provide catalog data for nameplates, labels, and markers.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.

1.06 EXTRA MATERIALS
A. See Section 01 6000 - Product Requirements for additional requirements.

PART 2 PRODUCTS

2.01 IDENTIFICATION REQUIREMENTS
A. Identification for Equipment:
   1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
B. Identification for Conductors and Cables:
   1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 05 19.
   2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.

2.02 MANUFACTURERS
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 IDENTIFICATION NAMEPLATES AND LABELS
A. Identification Nameplates:
   1. Materials:
   2. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
B. Identification Labels:
   1. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
   2. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
C. Nameplates: Engraved three-layer laminated plastic, black letters on white background.
D. Locations:
   1. Each electrical distribution and control equipment enclosure.
   2. Communication cabinets.
   3. Disconnect switches, and starters.
E. Letter Size:
   1. Use 1/8 inch letters for identifying individual equipment and loads.
   2. Use 1/4 inch letters for identifying grouped equipment and loads.

2.04 WIRE AND CABLE MARKERS
A. Manufacturers:
   1. Panduit Corp.
   2. Substitutions: See Section 01 60 00 - Product Requirements.
B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
D. Legend: Power source and circuit number or other designation indicated.
E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
F. Minimum Text Height: 1/8 inch.
G. Color: Black text on white background unless otherwise indicated.
H. Description: split sleeve type wire markers.
I. Locations: Each conductor at panelboard gutters, pull boxes, outlet boxes, and junction boxes each load connection.
J. Legend:
   1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
   2. Control Circuits: Control wire number indicated on shop drawings.

2.05 VOLTAGE MARKERS
A. Manufacturers: Panduit Corp
   1. Substitutions: See Section 01 60 00 - Product Requirements.
B. Minimum Size:
1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.

C. Legend:
   1. Markers for Voltage Identification: Highest voltage present.
   2. Markers for System Identification:
      a. Emergency Power System: Text "EMERGENCY".
      b. Other Systems: Type of service.

D. Color: Black text on orange background unless otherwise indicated.

E. Location: Furnish markers for each conduit longer than 6 feet.

F. Spacing: 20 feet on center.

G. Color:
   1. 480 Volt System: Brown.
   2. 208 Volt System: Yellow.

H. Legend:
   1. 480 Volt System: brown.
   2. 208 Volt System: yellow.

2.06 WARNING SIGNS AND LABELS

A. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.

B. Warning Signs:
   1. Materials:
   2. Minimum Size: 7 by 10 inches unless otherwise indicated.

C. Warning Labels:
   1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
   3. Minimum Size: 2 by 4 inches unless otherwise indicated.

PART 3 EXECUTION

3.01 PREPARATION

A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

B. Degrease and clean surfaces to receive nameplates and labels.

3.02 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
   3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
   4. Elevated Equipment: Legible from the floor or working platform.
5. Interior Components: Legible from the point of access.
6. Conductors and Cables: Legible from the point of access.

C. Install identification products centered, level, and parallel with lines of item being identified.
D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.

END OF SECTION
SECTION 26 09 23
LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Occupancy sensors.
   B. Time switches.
   C. In-wall interval timers.
   D. Outdoor photo controls.
   E. Daylighting controls.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   C. Section 26 05 37 - Boxes.
   D. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   E. Section 26 09 19 - Enclosed Contactors: Lighting contactors.
   F. Section 26 09 43 - Network Lighting Controls - Lutron.
   G. Section 26 27 26 - Wiring Devices: Devices for manual control of lighting, including wall switches, wall dimmers, fan speed controllers, and wall plates.
   H. Section 26 51 00 - Interior Lighting.
   I. Section 26 56 00 - Exterior Lighting.
   J. Section 01 91 00 - Commissioning
   K. Section 01 91 10 - Functional Testing Procedures
   L. Section 23 08 10 - Control Systems Commissioning

1.03 REFERENCE STANDARDS
   B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   C. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
   D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   E. NFPA 70 - National Electrical Code.
   F. UL 773A - Nonindustrial Photoelectric Switches for Lighting Control.
   G. UL 916 - Energy Management Equipment.
   H. UL 917 - Clock-Operated Switches.
   I. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate the placement of lighting control devices with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate the placement of wall switch occupancy sensors with actual installed door swings.
3. Coordinate the placement of occupancy sensors with millwork, furniture, equipment or other potential obstructions to motion detection coverage installed under other sections or by others.
4. Coordinate the placement of photo sensors for daylighting controls with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install lighting control devices until final surface finishes and painting are complete.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
C. Shop Drawings:
   1. Occupancy Sensors: Provide lighting plan indicating location, model number, and orientation of each occupancy sensor and associated system component.
   2. Daylighting Controls: Provide lighting plan indicating location, model number, and orientation of each photo sensor and associated system component.
D. Field Quality Control Reports.
E. Manufacturer's Installation Instructions: Include application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
F. Operation and Maintenance Data: Include detailed information on device programming and setup.
G. Project Record Documents: Record actual installed locations and settings for lighting control devices.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

1.08 FIELD CONDITIONS
A. Maintain field conditions within manufacturer's required service conditions during and after installation.
1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide five year manufacturer warranty for all occupancy sensors.
   C. Provide two year manufacturer warranty for all daylighting controls.

PART 2 PRODUCTS
2.01 ALL LIGHTING CONTROL DEVICES
   A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
   B. Unless specifically indicated to be excluded, provide all required conduit, wiring, connectors, hardware, components, accessories, etc. as required for a complete operating system.
   C. Products for Switching of Electronic Fluorescent Ballasts: Tested and rated to be suitable for peak inrush currents specified in NEMA 410.

2.02 OCCUPANCY SENSORS
   A. Manufacturers:
      1. Hubbell Building Automation, Inc: www.hubbellautomation.com
      5. Substitutions: See Section 01 60 00 - Product Requirements.
      6. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.
   B. All Occupancy Sensors:
      1. Description: Factory-assembled commercial specification grade devices for indoor use capable of sensing both major motion, such as walking, and minor motion, such as small desktop level movements, according to published coverage areas, for automatic control of load indicated.
      2. Sensor Technology:
         a. Passive Infrared/Ultrasonic Dual Technology Occupancy Sensors: Designed to detect occupancy using a combination of both passive infrared and ultrasonic technologies.
      3. Provide LED to visually indicate motion detection with separate color LEDs for each sensor type in dual technology units.
      4. Operation: Unless otherwise indicated, occupancy sensor to turn load on when occupant presence is detected and to turn load off when no occupant presence is detected during an adjustable turn-off delay time interval.
      5. Dual Technology Occupancy Sensors: Field configurable turn-on and hold-on activation with settings for activation by either or both sensing technologies.
      6. Turn-Off Delay: Field adjustable, with time delay settings up to 30 minutes.
      7. Sensitivity: Field adjustable.
      8. Adaptive Technology: Field selectable; capable of self-adjusting sensitivity and time delay according to conditions.
      9. Compatibility (Non-Dimming Sensors): Suitable for controlling incandescent lighting, low-voltage lighting with electronic and magnetic transformers, fluorescent lighting with electronic and magnetic ballasts, and fractional motor loads, with no minimum load requirements.
      10. Load Rating for Line Voltage Occupancy Sensors: As required to control the load indicated on drawings.
C. Wall Switch Occupancy Sensors:
   1. All Wall Switch Occupancy Sensors:
      a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated manual control capability, and no leakage current to load in off mode.
      b. Operation: Field selectable to operate either as occupancy sensor (automatic on/off) or as vacancy sensor (manual-on/automatic off).
      c. Manual-Off Override Control: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
   2. Passive Infrared/Ultrasonic Dual Technology Wall Switch Occupancy Sensors: Capable of detecting motion within an area of 900 square feet.
      a. Products:
         1) Hubbell Building Automation.
         2) Watt Stopper.
         3) Sensor switch.
         4) Substitutions: See Section 01 60 00 - Product Requirements.

D. Wall Dimmer Occupancy Sensors:
   1. General Requirements:
      a. Description: Occupancy sensors designed for installation in standard wall box at standard wall switch mounting height with a field of view of 180 degrees, integrated dimming control capability, and no leakage current to load in off mode.
      b. Manual-Off Override Control Capability: When used to turn off load while in automatic-on mode, unit to revert back to automatic mode after no occupant presence is detected during the delayed-off time interval.
      c. Dimmer: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, and listed as complying with UL 1472; type and rating suitable for load controlled.
      d. Provide field adjustable dimming preset for occupied state.

E. Ceiling Mounted Occupancy Sensors:
   1. All Ceiling Mounted Occupancy Sensors:
      a. Description: Low profile occupancy sensors designed for ceiling installation.
      b. Unless otherwise indicated or required to control the load indicated on drawings, provide low voltage units, for use with separate compatible accessory power packs.
      c. Provide field selectable setting for disabling LED motion detector visual indicator.
      d. Occupancy sensor to be field selectable as either manual-on/automatic-off or automatic on/off.
      e. Finish: White unless otherwise indicated.
   2. Passive Infrared/Ultrasonic Dual Technology Ceiling Mounted Occupancy Sensors:
      a. Standard Range Sensors: Capable of detecting motion within an area of 2000 sqft at a mounting height of 9 feet, with a field of view of 360 degrees.
         1) Products:
            (a) Hubbell Building Automation.
            (b) Sensor Switch.
            (c) Watt Stopper.
            (d) Substitutions: See Section 01 60 00 - Product Requirements.

F. Power Packs for Low Voltage Occupancy Sensors:
1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage occupancy sensors for switching of line voltage loads.

2. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.

3. Input Supply Voltage: Dual rated for 120/277 V ac.

4. Load Rating:
   a. Incandescent Load: Not less than 15 A.
   b. Fluorescent Load: Not less than 20 A.
   c. Motor Load: Not less than 1 HP.

2.03 TIME SWITCHES

A. Manufacturers:
   1. Intermatic, Inc: www.intermatic.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
   5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Digital Electronic Time Switches:
   1. Description: Factory-assembled solid state programmable controller with LCD display, listed and labeled as complying with UL 916 or UL 917.
   2. Program Capability:
      a. Astronomic Time Switches: Single channel, capable of different schedule for each day of the week with additional holiday schedule available to override normal schedule for selected days and field-configurable astronomic feature to automatically adjust for seasonal changes in sunrise and sunset times.
   3. Schedule Capacity: Not less than 16 programmable on/off operations.
   4. Provide automatic daylight savings time and leap year compensation.
   5. Provide power outage backup to retain programming and maintain clock.
   6. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.
   7. Provide remote photocell input with light level adjustment.
   8. Input Supply Voltage: As indicated on the drawings.
   9. Output Switch Contact Ratings:
      a. Resistive Load: Not less than 30 A at 120-277 V ac.
      b. Tungsten Load: Not less than 5 A at 120 V ac.
      c. Inductive Load: Not less than 30 A at 120-277 V ac.
      d. Ballast Load: Not less than 20 A at 120 V ac or 6 A at 277 V ac.
      e. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 240 V ac.
   10. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:
      a. Indoor clean, dry locations: Type 1.

C. Electromechanical Time Switches:
   1. Description: Factory-assembled controller with motor-operated timing dial mechanism and adjustable trippers for setting on/off operations, listed and labeled as complying with UL 917.
   2. Program Capability:
      a. 24-Hour Time Switches: With same schedule for each day of the week and skip-a-day feature to omit selected days.
   3. Schedule Capacity:
a. 24-Hour Time Switches: Accommodating not less than 12 pairs of selected on/off operations per day.

4. Manual override: Capable of overriding current schedule both permanently and temporarily until next scheduled event.

5. Input Supply Voltage: As indicated on the drawings.

6. Output Switch Configuration: As required to control the load indicated on drawings.

7. Output Switch Configuration: SPST dry unpowered maintained contacts.

8. Output Switch Contact Ratings: As required to control the load indicated on drawings.

9. Output Switch Contact Ratings:
   a. Resistive Load: Not less than 40 A at 120-277 V ac.
   b. Tungsten Load: Not less than 40 A at 120 V ac.
   c. Inductive Load: Not less than 20 A at 120-277 V ac.
   d. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 240 V ac.

10. Provide lockable enclosure; environmental type per NEMA 250 as specified for the following installation locations:

2.04 IN-WALL INTERVAL TIMERS

A. Manufacturers:
   1. Intermatic, Inc: www.intermatic.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
   5. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

B. Digital Electronic In-Wall Interval Timers:
   1. Description: Factory-assembled solid state programmable controller with LCD display, suitable for mounting in standard wall box, and listed and labeled as complying with UL 916 or UL 917.
   2. Program Capability: Designed to turn load off at end of preset time interval.
   3. Time Interval: Field selectable range of presets available up to 12 hours.
   4. Provide field selectable audible and visual indication to warn that end of interval operation is about to turn off load.
   5. Provide power outage backup to retain programming and maintain clock.
   6. Manual override: Capable of both turning load off and resetting timer to original preset time interval.
   7. Switch Configuration: Suitable for use in either SPST or 3-way application.
   8. Contact Ratings:
      a. Resistive Load: Not less than 20 A at 120-277 V ac.
      b. Tungsten Load: Not less than 15 A at 120 V ac.
      c. Ballast Load: Not less than 16 A at 120-277 V ac.
      d. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 240 V ac.

C. Spring Wound In-Wall Interval Timers:
   1. Description: Factory-assembled controller with mechanical spring wound timing mechanism requiring no electricity to operate; suitable for mounting in standard wall box; rotary control operator with matching wall plate factory marked with time interval units; listed and labeled as complying with UL 916 or UL 917.
   2. Program Capability: Designed to turn load off at end of preset time interval.
   3. Time Interval: User selectable from zero up to 15 minutes.
   5. Switch Configuration: SPST.
   6. Contact Ratings: As required to control the load indicated on drawings.
7. Contact Ratings:
   a. Resistive Load: Not less than 20 A at 120 V ac or 10 A at 277 V ac.
   b. Inductive Load: Not less than 20 A at 120 V ac or 10 A at 277 V ac.
   c. Tungsten Load: Not less than 7 A at 120 V ac.
   d. Motor Load: Not less than 1 HP at 120 V ac or 2 HP at 250 V ac.

2.05 OUTDOOR PHOTO CONTROLS

A. Manufacturers:
   1. Intermatic, Inc: www.intermatic.com/#sl.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Stem-Mounted Outdoor Photo Controls:
   1. Description: Direct-wired photo control unit with threaded conduit mounting stem and
      field-adjustable swivel base, listed and labeled as complying with UL 773A.
   2. Housing: Weatherproof, impact resistant polycarbonate.
   4. Provide external sliding shield for field adjustment of light level activation.
   5. Light Level Activation: 1 to 5 footcandles turn-on and 3 to 1 turn-off to turn-on ratio with
      delayed turn-off.
   6. Voltage: As required to control the load indicated on the drawings.
   7. Failure Mode: Fails to the on position.
   8. Load Rating: As required to control the load indicated on the drawings.
   9. Provide accessory wall-mounting bracket where indicated or as required to complete
      installation.

2.06 DAYLIGHTING CONTROLS

A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
   5. Source Limitations: Furnish products produced by a single manufacturer and obtained
      from a single supplier.

B. System Description: Control system consisting of photo sensors and compatible control
   modules and power packs, contactors, or relays as required for automatic control of load
   indicated according to available natural light; capable of integrating with occupancy sensors
   and manual override controls.

C. Daylighting Control Photo Sensors: Low voltage class 2 photo sensor units with output signal
   proportional to the measured light level and provision for zero or offset based signal.
   1. Sensor Type: Filtered silicon photo diode.
   2. Sensor Range:
      a. Indoor Photo Sensors: 5 to 100 footcandles.
   3. Finish: White unless otherwise indicated.
   4. Where wired sensors are indicated, wireless sensors are acceptable provided that all
      components and wiring modifications necessary for proper operation are included.
   5. Wireless Daylighting Control Photo Sensors:
      a. RF Range: 30 feet through typical construction materials.
      b. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits:
         Comply with FCC requirements of CFR, Title 47, Part 15, for Class B application.
      c. Power: Battery-operated with minimum ten-year battery life.
D. Dimming Photo Sensors: Photo sensor units with integral controller compatible with specified dimming ballasts, for direct continuous dimming of up to 50 ballasts.

E. Daylighting Control Switching Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors, for switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
   1. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
   2. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
   3. Control Capability:
      a. Multi-Zone Switching Modules: Capable of controlling up to three separately programmable channels.

F. Daylighting Control Switching Modules for Wireless Sensors:
   1. Description: Plenum rated, self-contained relay compatible with specified wireless photo sensors for switching of line voltage loads in response to changes in measured light levels according to selected settings.
   2. Operation: Unless otherwise indicated, load to be turned on when light level is below selected low set point and load to be turned off when light level is above selected high set point, with a no switching dead band between set points to prevent unwanted cycling.
   3. Input Delay: To prevent unwanted cycling due to intermittent light level fluctuations.
   4. Control Capability: Capable of controlling one programmable channel.
   5. Input Supply Voltage: Dual rated for 120/277 V ac.
   6. Load Rating:
      a. General Purpose Load: Not less than 16 A.
      b. Motor Load: Not less than 1/2 HP (120V) and 1.5 HP (277V).

G. Daylighting Control Dimming Modules for Low Voltage Sensors: Low voltage class 2 control unit compatible with specified photo sensors and with specified dimming ballasts, for both continuous dimming of compatible dimming ballasts and switching of compatible power packs, contactors, or relays in response to changes in measured light levels according to selected settings.
   1. Operation: Unless otherwise indicated, specified load to be continuously brightened as not enough daylight becomes available and continuously dimmed as enough daylight becomes available.
   2. Load to be turned off when available daylight is sufficient to fully dim the load, after the selected time delay.
   3. Control Capability: Capable of controlling up to three separately programmable channels, with up to 50 ballasts per channel.
   4. Dimming and Fade Rates: Adjustable from 5 to 60 seconds.
   5. Cut-Off Delay: Selectable and adjustable from 0 to 20 minutes.

H. Power Packs for Low Voltage Daylighting Control Modules:
   1. Description: Plenum rated, self-contained low voltage class 2 transformer and relay compatible with specified low voltage daylighting control modules for switching of line voltage loads. Provide quantity and configuration of power and slave packs with all associated wiring and accessories as required to control the load indicated on drawings.
   2. Input Supply Voltage: Dual rated for 120/277 V ac.
   3. Load Ratings: As required to control the load indicated on drawings.

I. Accessories:
   1. Where indicated, provide compatible accessory wall switches for manual override control.
2. Where indicated, provide compatible accessory wireless controls for manual override control.
   a. Products:
      1) Hubbell Building Automation.
      2) Sensor Switch.
      3) Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
   C. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
   D. Verify that final surface finishes are complete, including painting.
   E. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
   F. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
   G. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
   A. Provide extension rings to bring outlet boxes flush with finished surface.
   B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION
   A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
   B. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of lighting control devices provided under this section.
      1. Mounting Heights: Unless otherwise indicated, as follows:
         a. Wall Switch Occupancy Sensors: 48 inches above finished floor.
         b. In-Wall Time Switches: 48 inches above finished floor.
         c. In-Wall Interval Timers: 48 inches above finished floor.
      2. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
      3. Locate wall switch occupancy sensors on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
   C. Install lighting control devices in accordance with manufacturer's instructions.
   D. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
   E. Install lighting control devices plumb and level, and held securely in place.
   F. Where required and not furnished with lighting control device, provide wall plate in accordance with Section 26 27 26.
   G. Provide required supports in accordance with Section 26 05 29.
H. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

I. Identify lighting control devices in accordance with Section 26 05 53.

J. Occupancy Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.
   2. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors a minimum of 4 feet from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.

K. Outdoor Photo Control Locations:
   1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
   2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.

L. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.

M. Daylighting Control Photo Sensor Locations:
   1. Location Adjustments: Do not make adjustments to locations without obtaining approval from the Architect.
   2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
   3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.

N. Lamp Burn-In: Operate lamps at full output for minimum of 100 hours or prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.

O. Unless otherwise indicated, install power packs for lighting control devices above accessible ceiling or above access panel in inaccessible ceiling near the sensor location.

3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.

B. Inspect each lighting control device for damage and defects.

C. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals.

D. Test time switches to verify proper operation.

E. Test outdoor photo controls to verify proper operation, including time delays where applicable.

F. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.

G. Correct wiring deficiencies and replace damaged or defective lighting control devices.
3.05 ADJUSTING
   A. Adjust devices and wall plates to be flush and level.
   B. Adjust occupancy sensor settings to minimize undesired activations while optimizing energy savings, and to achieve desired function as indicated or as directed by Architect.
   C. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on passive infrared (PIR) and dual technology occupancy sensor lenses to block undesired motion detection.
   D. Adjust time switch settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings in written report to be included with submittals.
   E. Adjust external sliding shields on outdoor photo controls under optimum lighting conditions to achieve desired turn-on and turn-off activation as indicated or as directed by Architect.
   F. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.06 CLEANING
   A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.07 COMMISSIONING
   A. See Section 01 91 13 for commissioning requirements.

3.08 CLOSEOUT ACTIVITIES
   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
   B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
   C. Demonstration: Demonstrate proper operation of lighting control devices to Architect, and correct deficiencies or make adjustments as directed.

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SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Power distribution panelboards.
B. Lighting and appliance panelboards.
C. Overcurrent protective devices for panelboards.

1.02 RELATED REQUIREMENTS
A. Section 03 30 00 - Cast-in-Place Concrete: Concrete equipment pads.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
D. Section 26 05 29 - Hangers and Supports for Electrical Systems.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.
G. Section 26 22 00 - Low-Voltage Transformers: Small power centers with integral primary breaker, transformer, and panelboard.
H. Section 26 28 13 - Fuses: Fuses for fusible switches and spare fuse cabinets.
I. Section 26 43 00 - Surge Protective Devices.

1.03 REFERENCE STANDARDS
A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NECA 407 - Standard for Installing and Maintaining Panelboards.
D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
F. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
G. NEMA PB 1 - Panelboards.
H. NEMA PB 1.1 - General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
J. NFPA 70 - National Electrical Code.
K. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
L. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
M. UL 67 - Panelboards.
N. UL 98 - Enclosed and Dead-Front Switches.
O. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
Q. UL 943 - Ground-Fault Circuit-Interrupters.
R. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the work with other trades to avoid placement of ductwork, piping, equipment, or other potential obstructions within the dedicated equipment spaces and working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Coordinate the work with other trades to provide walls suitable for installation of flush-mounted panelboards where indicated.
   4. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   5. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for panelboards, enclosures, overcurrent protective devices, and other installed components and accessories.
   1. Include characteristic trip curves for each type and rating of overcurrent protective device upon request.
C. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, overcurrent protective device arrangement and sizes, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Include wiring diagrams showing all factory and field connections.
   2. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
E. Project Record Documents: Record actual installed locations of panelboards and actual installed circuiting arrangements.
F. Maintenance Data: Include information on replacement parts and recommended maintenance procedures and intervals.
G. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Panelboard Keys: Two of each different key.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, inspect, handle, and store panelboards in accordance with manufacturer's instructions and NECA 407.
B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
C. Handle carefully in accordance with manufacturer's written instructions to avoid damage to panelboard internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain ambient temperature within the following limits during and after installation of panelboards:
   1. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.

1.09 MAINTENANCE MATERIALS
A. See Section 01 6000 - Product Requirements, for additional provisions.
B. Furnish two of each panelboard key.

PART 2 PRODUCTS
2.01 MANUFACTURERS
C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
D. Substitutions: See Section 01 60 00 - Product Requirements.
E. Source Limitations: Furnish panelboards and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ALL PANELBOARDS
A. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
B. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature:
      a. Panelboards Containing Circuit Breakers: Between 23 degrees F and 104 degrees F.
C. Short Circuit Current Rating:
   1. Provide panelboards with listed short circuit current rating not less than the available fault current at the installed location as indicated on the drawings.
   2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
   3. Label equipment utilizing series ratings as required by NFPA 70.
D. Panelboards Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.
E. Mains: Configure for top or bottom incoming feed as indicated or as required for the installation.

F. Branch Overcurrent Protective Devices: Replaceable without disturbing adjacent devices.

G. Bussing: Sized in accordance with UL 67 temperature rise requirements.
   1. Provide fully rated neutral bus unless otherwise indicated, with a suitable lug for each feeder or branch circuit requiring a neutral connection.
   2. Provide solidly bonded equipment ground bus in each panelboard, with a suitable lug for each feeder and branch circuit equipment grounding conductor.
   3. Provide separate isolated/insulated ground bus where indicated or where isolated grounding conductors are provided.

H. Conductor Terminations: Suitable for use with the conductors to be installed.

I. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
   2. Boxes: Galvanized steel unless otherwise indicated.
      a. Provide wiring gutters sized to accommodate the conductors to be installed.
   3. Fronts:
      a. Fronts for Surface-Mounted Enclosures: Same dimensions as boxes.
      b. Fronts for Flush-Mounted Enclosures: Overlap boxes on all sides to conceal rough opening.
      c. Finish for Painted Steel Fronts: Manufacturer's standard grey unless otherwise indicated.
   4. Lockable Doors: All locks keyed alike unless otherwise indicated.
   5. Metal frame for type written directory
   6. 

J. Future Provisions: Prepare all unused spaces for future installation of devices including bussing, connectors, mounting hardware and all other required provisions.

K. Panelboard Contactors: Where panelboard contactors are indicated, provide electrically operated, mechanically held magnetic contactor complying with NEMA ICS 2.
   1. Ampere Rating: Not less than ampere rating of panelboard bus.
   2. Short Circuit Current Rating: Not less than the panelboard short circuit current rating.
   3. Coil Voltage: As required for connection to control system indicated.

L. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.

M. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.

2.03 POWER DISTRIBUTION PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, power and feeder distribution type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:
   1. SQ D
   2. General Electric
   3. Eaton Cutler Hammer
4. Substitutions: See Section 01 60 00 - Product Requirements.

C. Conductor Terminations:
   1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
   2. Main and Neutral Lug Type: Mechanical.

D. Bussing:
   1. Phase and Neutral Bus Material: Copper.
   2. Ground Bus Material: Copper.

E. Circuit Breakers:
   1. Provide bolt-on type or plug-in type secured with locking mechanical restraints.
   2. Provide thermal magnetic circuit breakers unless otherwise indicated.
   3. Provide electronic trip circuit breakers where indicated.

F. Enclosures:
   1. Provide surface-mounted enclosures unless otherwise indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable continuous hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide metal circuit directory holder mounted on inside of door.

G. Manufacturers:
   1. SQ.D or Equal.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

H. Description: NEMA PB 1, circuit breaker type.

I. Service Conditions:
   1. Altitude: 1000 feet.
   2. Temperature: 55 degrees F.

J. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard.

K. Minimum integrated short circuit rating: As indicated.
   1. 240 Volt Panelboards: 14,000 amperes rms symmetrical (minimum).
   2. 480 Volt Panelboards: 21,000 amperes rms symmetrical (minimum).

L. Molded Case Circuit Breakers: With integral thermal and instantaneous magnetic trip in each pole; UL listed. For air conditioning equipment branch circuits provide circuit breakers UL listed as Type HACR.

M. Molded Case Circuit Breakers with Current Limiters: With replaceable current limiting elements, in addition to integral thermal and instantaneous magnetic trip in each pole; UL listed.

N. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated.

O. Enclosure: NEMA PB 1, Type 1, 5 34" deep, 20" wide, cabinet box. With continued hinge and lock.

P. Cabinet Front: Surface type, fastened with , hinged door with flush lock, finished in manufacturer's standard gray enamel.

2.04 LIGHTING AND APPLIANCE PANELBOARDS

A. Description: Panelboards complying with NEMA PB 1, lighting and appliance branch circuit type, circuit breaker type, and listed and labeled as complying with UL 67; ratings, configurations and features as indicated on the drawings.

B. Products:
   1. SQD.
2. General Electric.
3. Eaton Cutler Hammer.
4. Substitutions: See Section 01 60 00 - Product Requirements.

C. Conductor Terminations:
   1. Main and Neutral Lug Material: Copper, suitable for terminating copper conductors only.
   2. Main and Neutral Lug Type: Mechanical.

D. Bussing:
   2. Phase and Neutral Bus Material: Copper.

E. Circuit Breakers: Thermal magnetic bolt-on type unless otherwise indicated.

F. Enclosures:
   1. Provide surface-mounted or flush-mounted enclosures as indicated.
   2. Fronts: Provide door-in-door trim with hinged cover for access to load terminals and wiring gutters, and separate lockable continuous hinged door with concealed hinges for access to overcurrent protective device handles without exposing live parts.
   3. Provide metal circuit directory holder mounted on inside of door.

G. Manufacturers:
   1. SQ.D or Equal.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

H. Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.

I. Panelboard Bus: Copper, ratings as indicated. Provide copper ground bus in each panelboard; provide insulated ground bus where scheduled.

J. Minimum Integrated Short Circuit Rating: As indicated.
   1. 240 Volt Panelboards: 14,000 amperes rms symmetrical (minimum).
   2. 480 Volt Panelboards: 21,000 amperes rms symmetrical (minimum).

K. Molded Case Circuit Breakers: Thermal magnetic trip circuit breakers, bolt-on type, with common trip handle for all poles; UL listed.
   1. Type SWD for lighting circuits.
   2. Type HACR for air conditioning equipment circuits.
   3. Class A ground fault interrupter circuit breakers where scheduled.
   4. Do not use tandem circuit breakers, or miniature circuit breakers.

L. Enclosure: NEMA PB 1, Type 1.

M. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards, 20 inches wide for 480 volt panelboards.

N. Cabinet Front: Flush or Surface cabinet front with concealed trim clamps, concealed hinge, metal directory frame, and flush lock all keyed alike. Finish in manufacturer's standard gray enamel.

2.05 OVERCURRENT PROTECTIVE DEVICES

A. Molded Case Circuit Breakers:
   1. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.
   2. Interrupting Capacity:
      a. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
1) 14000 rms symmetrical amperes at 240 VAC or 208 VAC.
2) 21000 rms symmetrical amperes at 480 VAC.

b. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
c. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

3. Conductor Terminations:
a. Provide mechanical lugs unless otherwise indicated.
b. Lug Material: Copper, suitable for terminating copper conductors only.

4. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
a. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
b. Provide interchangeable trip units where indicated.

5. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
a. Provide the following field-adjustable trip response settings:
   1) Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
   2) Long time delay.
   3) Short time pickup and delay.
   4) Instantaneous pickup.
   5) Ground fault pickup and delay where ground fault protection is indicated.


7. Provide the following circuit breaker types where indicated:
a. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

8. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

9. Provide listed high intensity discharge lighting rated circuit breakers with HID marking for all branch circuits serving HID lighting.

10. Do not use tandem circuit breakers.
11. Do not use handle ties in lieu of multi-pole circuit breakers.

2.06 SOURCE QUALITY CONTROL
A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Factory test panelboards according to NEMA PB 1.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as shown on the drawings.
B. Verify that the ratings and configurations of the panelboards and associated components are consistent with the indicated requirements.
C. Verify that mounting surfaces are ready to receive panelboards.
D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Install panelboards securely, in a neat and workmanlike manner in accordance with NECA 1 (general workmanship), NECA 407 (panelboards), and NEMA PB 1.1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 05 29.

E. Install panelboards plumb.

F. Install flush-mounted panelboards so that trims fit completely flush to wall with no gaps and rough opening completely covered.

G. Mount panelboards such that the highest position of any operating handle for circuit breakers or switches does not exceed 79 inches above the floor or working platform.

H. Mount floor-mounted power distribution panelboards on properly sized 4 inch high concrete pad constructed in accordance with Section 03 30 00.

I. Provide minimum of six spare 1 inch trade size conduits out of each flush-mounted panelboard stubbed into accessible space above ceiling and below floor.

J. Provide grounding and bonding in accordance with Section 26 05 26.
   1. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on isolated/insulated ground bus.
   2. Terminate branch circuit isolated grounding conductors on isolated/insulated ground bus only. Do not terminate on solidly bonded equipment ground bus.

K. Install all field-installed branch devices, components, and accessories.

L. Set field-adjustable circuit breaker tripping function settings as determined by overcurrent protective device coordination study performed according to Section 26 05 73.

M. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

N. Install panelboards in accordance with NEMA PB 1.1 and NECA 1.

O. Install panelboards plumb. Install recessed panelboards flush with wall finishes, where installed surface mounted secure or anchor panelboard to brick or cinder block wall.

P. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.

Q. Provide filler plates to cover unused spaces in panelboards.

R. Provide circuit breaker lock-on devices to prevent unauthorized personnel from de-energizing essential loads where indicated. Also provide for the following:
   1. Emergency and night lighting circuits.
   2. Fire detection and alarm circuits.
   3. Communications equipment circuits.
   4. Intrusion detection and access control system circuits.
   5. Video surveillance system circuits.

S. Identify panelboards in accordance with Section 26 05 53.

T. Provide computer-generated circuit directory for each lighting and appliance panelboard and each power distribution panelboard provided with a door, clearly and specifically indicating the loads served. Identify spares and spaces.

U. Provide identification nameplate for each panelboard in accordance with Section 26 0553.

V. Provide arc flash warning labels in accordance with NFPA 70.

W. Provide spare conduits out of each recessed panelboard to an accessible location above ceiling. Identify each as SPARE.
   1. Minimum spare conduits: 5 empty 1 inch.
X. Ground and bond panelboard enclosure according to Section 26 0526.

3.03 FIELD QUALITY CONTROL
A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.
B. Perform field inspection and testing in accordance with Section 01 4000.
C. Inspect and test in accordance with NETA STD ATS, except Section 4.
D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.
E. Test GFCI circuit breakers to verify proper operation.
F. Test shunt trips to verify proper operation.
G. Procure services of a qualified manufacturer’s representative to observe installation and assist in inspection, testing, and adjusting. Include manufacturer's reports with field quality control submittals.
H. Correct deficiencies and replace damaged or defective panelboards or associated components.
I. Perform inspections and tests listed in NETA STD ATS, Section 7.5 for switches, Section 7.6 for circuit breakers.

3.04 ADJUSTING
A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.
B. Adjust alignment of panelboard fronts.
C. Load Balancing: For each panelboard, rearrange circuits such that the difference between each measured steady state phase load does not exceed 20 percent and adjust circuit directories accordingly. Maintain proper phasing for multi-wire branch circuits.

3.05 CLEANING
A. Clean dirt and debris from panelboard enclosures and components according to manufacturer's instructions.
B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 27 17
EQUIPMENT WIRING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Electrical connections to equipment.

1.02 RELATED REQUIREMENTS
A. Section 26 05 34 - Conduit.
B. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables (600 V and Less).
C. Section 26 05 37 - Boxes.
D. Section 26 27 26 - Wiring Devices.

1.03 REFERENCE STANDARDS
A. NEMA WD 1 - General Color Requirements for Wiring Devices.
B. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
C. NFPA 70 - National Electrical Code.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.
C. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.05 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 COORDINATION
A. Obtain and review shop drawings, product data, manufacturer’s wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
B. Determine connection locations and requirements.
C. Sequence rough-in of electrical connections to coordinate with installation of equipment.
D. Sequence electrical connections to coordinate with start-up of equipment.

PART 2 PRODUCTS

2.01 MATERIALS
A. Cords and Caps: NEMA WD 6; match receptacle configuration at outlet provided for equipment.
   1. Colors: Conform to NEMA WD 1.
   2. Cord Construction: NFPA 70, Type SO, multiconductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
   3. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.
   4. Product:
   5. Substitutions: See Section 01 60 00 - Product Requirements.
B. Disconnect Switches: As specified in Section and in individual equipment sections.
C. Wiring Devices: As specified in Section 26 27 26.
D. Flexible Conduit: As specified in Section 26 05 34.
E. Wire and Cable: As specified in Section 26 05 19.
F. Boxes: As specified in Section 26 05 37.

2.02 EQUIPMENT CONNECTIONS

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that equipment is ready for electrical connection, wiring, and energization.

3.02 ELECTRICAL CONNECTIONS

A. Make electrical connections in accordance with equipment manufacturer's instructions.
B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations.
C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
D. Provide receptacle outlet to accommodate connection with attachment plug.
E. Provide cord and cap where field-supplied attachment plug is required.
F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
G. Install disconnect switches, controllers, control stations, and control devices to complete equipment wiring requirements.
H. Install terminal block jumpers to complete equipment wiring requirements.
I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
J. Coolers and Freezers: Cut and seal conduit openings in freezer and cooler walls, floor, and ceilings.

END OF SECTION
SECTION 26 27 26  
WIRING DEVICES

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Wall switches.
B. Wall dimmers.
C. Receptacles.
D. Wall plates.
E. Floor box service fittings.

1.02 RELATED REQUIREMENTS
A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables: Manufactured wiring systems for use with access floor boxes with compatible pre-wired connectors.
B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
C. Section 26 05 33.23 - Surface Raceways: Surface raceway systems, including multioutlet assemblies.
D. Section 26 05 37 - Boxes.
E. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
F. Section 26 09 23 - Lighting Control Devices: Devices for automatic control of lighting, including occupancy sensors, in-wall time switches, and in-wall interval timers.
G. Section 26 27 17 - Equipment Wiring: Cords and plugs for equipment.
I. Section 27 10 05 - Structured Cabling for Voice and Data - Inside-Plant: Voice and data jacks.

1.03 REFERENCE STANDARDS
B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification).
C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
E. NEMA WD 1 - General Color Requirements for Wiring Devices.
F. NEMA WD 6 - Wiring Devices - Dimensional Specifications.
G. NFPA 70 - National Electrical Code.
H. UL 20 - General-Use Snap Switches.
I. UL 498 - Attachment Plugs and Receptacles.
J. UL 514D - Cover Plates for Flush-Mounted Wiring Devices.
K. UL 943 - Ground-Fault Circuit-Interrupters.
L. UL 1472 - Solid-State Dimming Controls.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
5. Coordinate the core drilling of holes for poke-through assemblies with the work covered under other sections.
6. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Sequencing:
1. Do not install wiring devices until final surface finishes and painting are complete.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
C. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
D. Operation and Maintenance Data:
   1. GFCI Receptacles: Include information on status indicators.
E. Project Record Documents: Record actual installed locations of wiring devices.
F. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Wall Plates: One of each style, size, and finish.
   3. Extra Flush Floor Service Fittings: Two of each type.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Products: Listed, classified, and labeled as suitable for the purpose intended.
E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND PROTECTION
A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

1.08 EXTRA MATERIALS
A. See Section 01 6000 - Product Requirements, for additional provisions.
B. Furnish two of each style, size, and finish wall plate.

PART 2 PRODUCTS
2.01 MANUFACTURERS
D. Pass & Seymour, a brand of Legrand North America, Inc; : www.legrand.us
G. Substitutions: See Section 01 60 00 - Product Requirements.
H. Source Limitations: Where possible, for each type of wiring device furnish products produced by a single manufacturer and obtained from a single supplier.

2.02 APPLICATIONS
A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
C. Provide weather resistant GFI receptacles with specified weatherproof covers for all receptacles installed outdoors or in damp or wet locations.
D. Provide tamper resistant receptacles for receptacles installed in the following areas specified:
   1. Preschools and elementary education facilities.
   2. Business offices, corridors, waiting rooms and the like in clinics, medical and dental offices and outpatient facilities.
E. Provide GFI protection for all receptacles installed within 6 feet of sinks.
F. Provide GFCI protection for receptacles serving electric drinking fountains.
G. Unless noted otherwise, do not use combination switch/receptacle devices.
H. For flush floor service fittings, use carpet flanges for installations in carpeted floors.

2.03 ALL WIRING DEVICES
A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

2.04 WALL SWITCHES
A. Manufacturers:
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. All Wall Switches: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
   1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
C. Standard Wall Switches: Commercial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
D. Wall Switches: Heavy Duty, AC only general-use snap switch, complying with NEMA WD 6 and WD 1.
   1. Body and Handle: Black plastic with toggle handle.
   2. Ratings:
      a. Voltage: 120 - 277 volts, AC.

3. Ratings: Match branch circuit and load characteristics.

E. Switch Types: Single pole, double pole, 3-way, and 4-way.

2.05 WALL DIMMERS

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. All Wall Dimmers: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.

C. Control: Slide control type with separate on/off switch.

2.06 RECEPTACLES

A. Manufacturers:
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. All Receptacles: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
2. NEMA configurations specified are according to NEMA WD 6.

C. Convenience Receptacles:
1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, tamper resistant; single or duplex as indicated on the drawings.
   a. Products:
      1) Hubbell Wiring Devices.
      2) Leviton.
      3) Pass & Saymore.
      4) Substitutions: See Section 01 60 00 - Product Requirements.

D. GFI Receptacles:
1. All GFI Receptacles: Provide with feed-through protection, light to indicate ground fault tripped condition and loss of protection, and list as complying with UL 943, class A.

E. Receptacles: Heavy duty, complying with NEMA WD 6 and WD 1.
1. Device Body: Black plastic.
2. Configuration: NEMA WD 6, type as specified and indicated.

F. Convenience Receptacles: Type 5 - 20.

G. Single Convenience Receptacles.

H. Duplex Convenience Receptacles.
I. **GFCI Receptacles:** Convenience receptacle with integral ground fault circuit interrupter to meet regulatory requirements.

### 2.07 TELEPHONE JACKS

A. **Product:** AMP manufacturing

B. **Substitutions:** See Section 01 60 00 - Product Requirements.

### 2.08 WALL PLATES

A. **Manufacturers:**
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. **All Wall Plates:** Comply with UL 514D.
   1. **Configuration:** One piece cover as required for quantity and types of corresponding wiring devices.
   2. **Size:** Standard;
   3. **Screws:** Metal with slotted heads finished to match wall plate finish.

C. **Stainless Steel Wall Plates:** Brushed satin finish, Type 302 stainless steel.

D. **Weatherproof Covers for Damp Locations:** Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.

E. **Weatherproof Covers for Wet Locations:** Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

F. **Decorative Cover Plates:** stainless steel.

G. **Jumbo Cover Plates:** stainless steel.

H. **Weatherproof Cover Plates:** Gasketed cast metal with hinged cover.

### 2.09 FLOOR BOX SERVICE FITTINGS

A. **Manufacturers:**
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. **Description:** Service fittings compatible with floor boxes provided under Section 26 05 37 with all components, adapters, and trims required for complete installation.

C. **Flush Floor Service Fittings:**
   1. **Dual Service Flush Combination Outlets:**
      a. **Cover:** Rectangular.
      b. **Configuration:**
         1) **Power:** One standard convenience duplex receptacle(s) with duplex flap opening(s).
         2) **Communications:** Two Data Drops.
         3) **Voice and Data Jacks:** As specified in Section 27 10 05.
   2. **Accessories:**
      a. **Carpet Flanges:** Finish to match covers; configuration as required to accommodate specified covers.
2.10 POKE-THROUGH ASSEMBLIES
   A. Description: Assembly comprising floor service fitting, poke-through component, fire stops and smoke barriers, and junction box for conduit termination; fire rating listed to match fire rating of floor and suitable for floor thickness where installed.
   B. Flush Floor Service Fittings:
      1. Dual Service Flush Combination Outlets:
         a. Cover: Hinged door(s).
         b. Configuration:
            1) Power: One standard convenience duplex receptacle(s).
            2) Communications: Two data drops.
            3) Voice and Data Jacks: As specified in Section 27 10 05.
      2. Accessories:
         a. Closure Plugs: Size and fire rating as required to seal unused core hole and maintain fire rating of floor.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
   C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
   D. Verify that final surface finishes are complete, including painting.
   E. Verify that floor boxes are adjusted properly.
   F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
   G. Verify that openings in access floor are in proper locations.
   H. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
   A. Provide extension rings to bring outlet boxes flush with finished surface.
   B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION
   A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
   B. Perform work in a neat and workmanlike manner in accordance with NECA 1, including mounting heights specified in that standard unless otherwise indicated.
   C. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of wiring devices provided under this section.
      1. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
      2. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
   D. Install wiring devices in accordance with manufacturer's instructions.
   E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.

G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.

H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.

I. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.

J. Unless otherwise indicated, GFCI receptacles may be connected to provide feed-through protection to downstream devices. Label such devices to indicate they are protected by upstream GFCI protection.

K. Install securely, in a neat and workmanlike manner, as specified in NECA 1.

L. Install wiring devices plumb and level with mounting yoke held rigidly in place.

M. Install wall switches with OFF position down.

N. Do not share neutral conductor on branch circuits utilizing wall dimmers.

O. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.

P. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.

Q. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.

R. Install poke-through closure plugs in each unused core holes to maintain fire rating of floor.

S. Install receptacles with grounding pole on top.

T. Connect wiring device grounding terminal to outlet box with bonding jumper.

U. Install decorative plates on switch, receptacle, and blank outlets in finished areas.

V. Connect wiring devices by wrapping conductor around screw terminal.

W. Use jumbo size plates for outlets installed in masonry walls.

X. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface mounted outlets.

3.04 INTERFACE WITH OTHER PRODUCTS

A. Coordinate locations of outlet boxes provided under Section 26 05 37 to obtain mounting heights.

B. Install wall switch 48 inches above finished floor.

C. Install convenience receptacle 18 inches above finished floor.

D. Install convenience receptacle 6 inches above backsplash of counter.

E. Install telephone jack 18 inches above finished floor.

F. Install telephone jack for side-reach wall telephone to position top of telephone at 54 inches above finished floor.
G. Install telephone jack for forward-reach wall telephone to position top of telephone at 48 inches above finished floor.
H. Coordinate installation of access floor boxes with access floor system provided under Section 09 6900.
I. Coordinate the installation of wiring devices with underfloor duct service fittings provided under Section 26 0540.

3.05 FIELD QUALITY CONTROL
A. Perform field inspection, testing, adjusting, and balancing in accordance with Section 01 40 00.
B. Inspect each wiring device for damage and defects.
C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
D. Operate each wall switch with circuit energized and verify proper operation.
E. Verify that each receptacle device is energized.
F. Test each receptacle to verify operation and proper polarity.
G. Test each GFCI receptacle for proper tripping operation according to manufacturer’s instructions.
H. Correct wiring deficiencies and replace damaged or defective wiring devices.
I. Verify that each telephone jack is properly connected and circuit is operational.

3.06 ADJUSTING
A. Adjust devices and wall plates to be flush and level.

3.07 CLEANING
A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION
SECTION 26 28 13
FUSES

PART 1  GENERAL

1.01  SECTION INCLUDES
A. Fuses.

1.02  RELATED REQUIREMENTS
A. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
B. Section 26 05 73 - Power System Studies: Additional criteria for the selection of protective devices specified in this section.
C. Section 26 24 13 - Switchboards: Fusible switches.
D. Section 26 24 16 - Panelboards: Fusible switches.
E. Section 26 28 18 - Enclosed Switches: Fusible switches.
F. Section 26 29 13 - Enclosed Controllers: Fusible switches.

1.03  REFERENCE STANDARDS
A. NEMA FU 1 - Low Voltage Cartridge Fuses.
B. NFPA 70 - National Electrical Code.
D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses.
E. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses.

1.04  ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
   2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
   3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05  SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Fuses: One set(s) of three for each type and size installed.
   3. Fuse Pullers: One set(s) compatible with each type and size installed.

1.06  QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.

E. Products: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.07 MAINTENANCE MATERIALS
A. See Section 01 6000 - Product Requirements, for additional provisions.
B. Furnish two fuse pullers.
C. Furnish three of each size and type fuse installed.

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Cooper Bussmann, a division of Cooper Industries: www.cooperindustries.com/#sle.
D. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 APPLICATIONS
A. Service Entrance:
   1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
B. General Purpose Branch Circuits: Class RK1, time-delay.
C. Primary Protection for Control Transformers: Class CC, time-delay.

2.03 FUSES
A. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose indicated.
B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
C. Provide fuses of the same type, rating, and manufacturer within the same switch.
D. Comply with UL 248-1.
E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
F. Voltage Rating: Suitable for circuit voltage.
G. Class R Fuses: Comply with UL 248-12.
H. Class CC Fuses: Comply with UL 248-4.
I. Power Load Feeder Switches: Class RK1 (time delay).
J. Motor Load Feeder Switches: Class RK1 (time delay).
K. Other Feeder Switches: Class RK1 (time delay).
L. General Purpose Branch Circuits: Class RK1 (time delay).
M. Motor Branch Circuits: Class L time delay.
N. Lighting Branch Circuits: Class G.
2.04 CLASS RK1 (TIME DELAY) FUSES

A. Manufacturers:
   1. Bussman Corp.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

B. Construction: Current limiting, dual-element fuse, 10 seconds minimum at 500% rated amps, with copper fuse element.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that fuse ratings are consistent with circuit voltage and manufacturer’s recommendations and nameplate data for equipment.

B. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Do not install fuses until circuits are ready to be energized.

B. Install fuses with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION
SECTION 26 28 17
ENCLOSED CIRCUIT BREAKERS

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Enclosed circuit breakers.

1.02 RELATED REQUIREMENTS
A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
D. Section 26 05 73 - Power System Studies: Additional criteria for the selection and adjustment of equipment and associated protective devices specified in this section.

1.03 REFERENCE STANDARDS
A. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service.
B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
E. NFPA 70 - National Electrical Code.
F. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
G. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
H. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
J. UL 943 - Ground-Fault Circuit-Interrupters.
K. UL 1053 - Ground-Fault Sensing and Relaying Equipment.

1.04 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate work with other trades. Avoid placement of ductwork, piping, equipment, or other potential obstructions within dedicated equipment spaces and within working clearances for electrical equipment required by NFPA 70.
   2. Coordinate arrangement of electrical equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Verify with manufacturer that conductor terminations are suitable for use with the conductors to be installed.
   4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

1.05 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for circuit breakers, enclosures, and other installed components and accessories.
C. Shop Drawings: Indicate outline and support point dimensions, voltage and current ratings, short circuit current ratings, conduit entry locations, conductor terminal information, and installed features and accessories.
   1. Clearly indicate whether proposed short circuit current ratings are fully rated or, where acceptable, series rated systems.
   2. Include documentation of listed series ratings.
D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Maintain one copy of each document on site.
D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
B. Handle carefully in accordance with manufacturer's written instructions to avoid damage to enclosed circuit breaker internal components, enclosure, and finish.

1.08 FIELD CONDITIONS
A. Maintain ambient temperature between 23 degrees F and 104 degrees F during and after installation of enclosed circuit breakers.

1.09 EXTRA MATERIALS
A. See Section 01 6000 - Product Requirements, for additional provisions.

PART 2 PRODUCTS
2.01 MANUFACTURERS
C. Schneider Electric; Square D Products: www.schneider-electric.us/#sle.
D. Substitutions: See Section 01 60 00 - Product Requirements.
E. Source Limitations: Furnish enclosed circuit breakers and associated components produced by the same manufacturer as the other electrical distribution equipment used for this project and obtained from a single supplier.

2.02 ENCLOSED CIRCUIT BREAKERS
A. Description: Units consisting of molded case circuit breakers individually mounted in enclosures.
B. Provide products listed and labeled by Underwriters Laboratories Inc. as suitable for the purpose indicated.
C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between 23 degrees F and 104 degrees F.

D. Short Circuit Current Rating:
   1. Provide enclosed circuit breakers with listed short circuit current rating not less than the available fault current at the installed location indicated on the drawings.
   2. Listed series ratings are acceptable, except where not permitted by motor contribution according to NFPA 70.
   3. Label equipment utilizing series ratings as required by NFPA 70.

E. Enclosed Circuit Breakers Used for Service Entrance: Listed and labeled as suitable for use as service equipment according to UL 869A.

F. Conductor Terminations: Suitable for use with the conductors to be installed.

G. Provide thermal magnetic circuit breakers unless otherwise indicated.

H. Provide electronic trip circuit breakers where indicated.

I. Provide insulated, groundable fully rated solid neutral assembly where a neutral connection is required, with a suitable lug for terminating each neutral conductor.

J. Provide solidly bonded equipment ground bus in each enclosed circuit breaker, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.
   2. Finish for Painted Steel Enclosures: Manufacturer's standard, factory applied grey unless otherwise indicated.
   3. Provide surface-mounted enclosures unless otherwise indicated.

L. Provide externally operable handle with means for locking in the OFF position.

M. Ground Fault Protection: Where ground-fault protection is indicated, provide system listed and labeled as complying with UL 1053.
   1. Where electronic circuit breakers equipped with integral ground fault protection are used, provide separate neutral current sensor where applicable.
   2. Where accessory ground fault sensing and relaying equipment is used, equip companion circuit breakers with ground-fault shunt trips.
      a. Use zero sequence ground fault detection method unless otherwise indicated.
      b. Provide test panel and field-adjustable ground fault pick-up and delay settings.

2.03 MOLDED CASE CIRCUIT BREAKERS

A. Description: Quick-make, quick-break, over center toggle, trip-free, trip-indicating circuit breakers listed and labeled as complying with UL 489, and complying with FS W-C-375 where applicable; ratings, configurations, and features as indicated on the drawings.

B. Interrupting Capacity:
   1. Provide circuit breakers with interrupting capacity as required to provide the short circuit current rating indicated, but not less than:
      a. 14000 min. rms symmetrical amperes at 240 VAC or 208 VAC.
      b. 21000 min. rms symmetrical amperes at 480 VAC.
   2. Fully Rated Systems: Provide circuit breakers with interrupting capacity not less than the short circuit current rating indicated.
3. Series Rated Systems: Provide circuit breakers listed in combination with upstream devices to provide interrupting rating not less than the short circuit current rating indicated.

C. Conductor Terminations:
   1. Provide mechanical lugs unless otherwise indicated.
   2. Lug Material: Copper, suitable for terminating copper conductors only.

D. Thermal Magnetic Circuit Breakers: For each pole, furnish thermal inverse time tripping element for overload protection and magnetic instantaneous tripping element for short circuit protection.
   1. Provide field-adjustable magnetic instantaneous trip setting for circuit breaker frame sizes 225 amperes and larger.
   2. Provide interchangeable trip units for circuit breaker frame sizes 225 amperes and larger.

E. Electronic Trip Circuit Breakers: Furnish solid state, microprocessor-based, true rms sensing trip units.
   1. Provide the following field-adjustable trip response settings:
      a. Long time pickup, adjustable by replacing interchangeable trip unit or by setting dial.
      b. Long time delay.
      c. Short time pickup and delay.
      d. Instantaneous pickup.
      e. Ground fault pickup and delay where ground fault protection is indicated.

F. Multi-Pole Circuit Breakers: Furnish with common trip for all poles.

G. Provide the following circuit breaker types where indicated:
   1. Ground Fault Circuit Interrupter (GFCI) Circuit Breakers: Listed as complying with UL 943, class A for protection of personnel.

H. Provide listed switching duty rated circuit breakers with SWD marking for all branch circuits serving fluorescent lighting.

I. Provide the following features and accessories where indicated or where required to complete installation:
   1. Shunt Trip: Provide coil voltage as required for connection to indicated trip actuator.

J. Molded Case Circuit Breakers: UL listed for the following service conditions:
   1. Temperature: 95 degrees F.
   2. Altitude: 1000 feet.

2.04 TRIP UNITS

A. Field-Adjustable Trip Circuit Breakers: Provide circuit breakers with frame sizes 200 amperes and larger with mechanism for adjusting long time continuous current, short time pickup current setting for automatic operation. Range of Adjustment: amperes.

B. Field-Changeable Ampere Rating Circuit Breaker: Provide circuit breakers with frame sizes 250 amperes and larger with changeable trip units.

C. Current Limiting Circuit Breaker: Provide circuit breaker as indicated with automatically-resetting current limiting elements in each pole. Let-through Current and Energy: Less than permitted for same size Class RK-5 fuse.

D. Solid-State Circuit Breaker: Provide circuit breaker as scheduled with electronic sensing, timing and tripping circuits for adjustable current settings; ground fault trip with zero sequence type ground fault sensor; instantaneous trip.

2.05 CURRENT LIMITERS

A. Current Limiters: Designed for application with molded case circuit breaker.
B. Coordinate limiter size with trip rating of circuit breaker to prevent nuisance tripping and to achieve interrupting current rating specified for circuit breaker.

C. Provide interlocks to trip circuit breaker and to prevent closing circuit breaker when limiter compartment cover is removed or when one or more limiter is not in place or has operated.

2.06 ACCESSORIES

A. Enclosures:
   1. Fabricate enclosures from steel.
   2. Finish: Manufacturer's standard enamel finish, gray color.

B. Provide accessories as scheduled.

C. Handle Lock: Include provisions for padlocking.

D. Provide mechanical trip device.

E. Provide grounding lug in each enclosure.

F. Provide products suitable for use as service entrance equipment where so applied.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that field measurements are as shown on the drawings.

B. Verify that the ratings of the enclosed circuit breakers are consistent with the indicated requirements.

C. Verify that mounting surfaces are ready to receive enclosed circuit breakers.

D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION

A. Install enclosed circuit breakers where indicated, in accordance with manufacturer's instructions.

B. Install enclosed circuit breakers securely, in a neat and workmanlike manner in accordance with NECA 1.

C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.

D. Provide required supports in accordance with Section 26 05 29.

E. Install enclosed circuit breakers plumb.

F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed circuit breakers such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.

G. Provide grounding and bonding in accordance with Section 26 05 26.

H. Set field-adjustable ground fault protection pickup and time delay settings as indicated.

I. Height: 5 feet to operating handle.

J. Provide identification nameplates for each enclosed circuit breaker in accordance with Section 26 0553.

K. Provide arc flash warning labels in accordance with NFPA 70.

3.03 FIELD QUALITY CONTROL

A. Perform inspection, testing, and adjusting in accordance with Section 01 40 00.

B. Inspect and test in accordance with manufacturer's instructions and NETA STD ATS, except Section 4.
C. Perform inspections and tests listed in NETA STD ATS, Section 7.6.1.1 for circuit breakers used for service entrance and for circuit breakers larger than 400 amperes. Tests listed as optional are not required.

D. Ground Fault Protection Systems: Test in accordance with manufacturer's instructions as required by NFPA 70.

E. Test GFCI circuit breakers to verify proper operation.

F. Test shunt trips to verify proper operation.

G. Correct deficiencies and replace damaged or defective enclosed circuit breakers.

H. Perform field inspection and testing in accordance with Section 01 4000.

I. Inspect and test each circuit breaker.

J. Inspect each circuit breaker visually.

K. Perform several mechanical ON-OFF operations on each circuit breaker.

L. Verify circuit continuity on each pole in closed position.

M. Determine that circuit breaker will trip on overcurrent condition, with tripping time to NEMA AB 1 requirements.

N. Include description of testing and results in test report.

3.04 ADJUSTING

A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING

A. Clean dirt and debris from circuit breaker enclosures and components according to manufacturer's instructions.

B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SECTION 26 28 18
ENCLOSED SWITCHES

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Enclosed safety switches.
   B. Fusible switches.
   C. Nonfusible switches.

1.02 RELATED REQUIREMENTS
   A. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   B. Section 26 05 29 - Hangers and Supports for Electrical Systems.
   C. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
   D. Section 26 05 73 - Power System Studies: Additional criteria for the selection of equipment and associated protective devices specified in this section.
   E. Section 26 28 13 - Fuses.
   G. Section 26 36 00 - Transfer Switches: Automatic and non-automatic switches listed for use as transfer switch equipment.

1.03 REFERENCE STANDARDS
   A. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
   C. NEMA FU 1 - Low Voltage Cartridge Fuses; National Electrical Manufacturers Association.
   D. NEMA KS 1 - Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
   E. NETA ATS - Standard For Acceptance Testing Specifications For Electrical Power Equipment And Systems.
   F. NFPA 70 - National Electrical Code.
   G. UL 50 - Enclosures for Electrical Equipment, Non-Environmental Considerations.
   H. UL 50E - Enclosures for Electrical Equipment, Environmental Considerations.
   I. UL 98 - Enclosed and Dead-Front Switches.

1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Provide manufacturer’s standard catalog pages and data sheets for enclosed switches and other installed components and accessories.
   C. Project Record Documents: Record actual locations of enclosed switches.

1.05 QUALITY ASSURANCE
   A. Conform to requirements of NFPA 70.

PART 2 PRODUCTS

2.01 MANUFACTURERS
   A. Eaton Corporation; Cutler-Hammer Products; Model: www.eaton.com/#sle.
2.02 ENCLOSED SAFETY SWITCHES

A. Description: Quick-make, quick-break enclosed safety switches listed and labeled as complying with UL 98; heavy duty; ratings, configurations, and features as indicated on the drawings.

B. Provide products listed, classified, and labeled as suitable for the purpose intended.

C. Unless otherwise indicated, provide products suitable for continuous operation under the following service conditions:
   1. Altitude: Less than 6,600 feet.
   2. Ambient Temperature: Between -22 degrees F and 104 degrees F.

D. Horsepower Rating: Suitable for connected load.

E. Voltage Rating: Suitable for circuit voltage.

F. Short Circuit Current Rating:

G. Provide with switch blade contact position that is visible when the cover is open.

H. Fuse Clips for Fusible Switches: As required to accept fuses indicated.

I. Conductor Terminations: Suitable for use with the conductors to be installed.

J. Provide solidly bonded equipment ground bus in each enclosed safety switch, with a suitable lug for terminating each equipment grounding conductor.

K. Enclosures: Comply with NEMA 250, and list and label as complying with UL 50 and UL 50E.
   1. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
      a. Indoor Clean, Dry Locations: Type 1.
      b. Outdoor Locations: Type 3R.

L. Provide safety interlock to prevent opening the cover with the switch in the ON position with capability of overriding interlock for testing purposes.

M. Heavy Duty Switches:
   1. Products:
      a. Schneider Electric.
      b. General Electric Co.
      c. Cutler Hammer.
   d. Substitutions: See Section 01 60 00 - Product Requirements.
   2. Comply with NEMA KS 1.
   3. Conductor Terminations:
      a. Provide mechanical lugs unless otherwise indicated.
      b. Provide compression lugs where indicated.
      c. Lug Material: Copper, suitable for terminating copper conductors only.
   4. Provide externally operable handle with means for locking in the OFF position, capable of accepting three padlocks.

2.03 COMPONENTS

A. Fusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
2. Handle lockable in OFF position.
3. Fuse clips: Designed to accommodate NEMA FU1, Class R fuses.

B. Nonfusible Switch Assemblies: NEMA KS 1, Type HD enclosed load interrupter knife switch.
   1. Externally operable handle interlocked to prevent opening front cover with switch in ON position.
   2. Handle lockable in OFF position.

C. Enclosures: NEMA KS 1.
   1. Interior Dry Locations: Type 1.
   2. Exterior Locations: Type 3R.

PART 3 EXECUTION

3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that the ratings of the enclosed switches are consistent with the indicated requirements.
   C. Verify that mounting surfaces are ready to receive enclosed safety switches.
   D. Verify that conditions are satisfactory for installation prior to starting work.

3.02 INSTALLATION
   A. Install enclosed switches in accordance with manufacturer's instructions.
   B. Install enclosed switches securely, in a neat and workmanlike manner in accordance with NECA 1.
   C. Arrange equipment to provide minimum clearances in accordance with manufacturer's instructions and NFPA 70.
   D. Provide required supports in accordance with Section 26 05 29.
   E. Install enclosed switches plumb.
   F. Except where indicated to be mounted adjacent to the equipment they supply, mount enclosed switches such that the highest position of the operating handle does not exceed 79 inches above the floor or working platform.
   G. Provide grounding and bonding in accordance with Section 26 05 26.
   H. Provide fuses complying with Section 26 28 13 for fusible switches as indicated or as required by equipment manufacturer's recommendations.
   I. Provide identification nameplate for each enclosed switch in accordance with Section 26 0553.
   J. Provide arc flash warning labels in accordance with NFPA 70.
   K. Install fuses in fusible disconnect switches.
   L. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.03 FIELD QUALITY CONTROL
   A. Perform field inspection, testing, and adjusting in accordance with Section 01 40 00.
   B. Inspect and test in accordance with NETA STD ATS, except Section 4.
   C. Perform inspections and tests listed in NETA STD ATS, Section 7.5.1.1.
   D. Correct deficiencies and replace damaged or defective enclosed safety switches or associated components.
3.04 ADJUSTING
   A. Adjust tightness of mechanical and electrical connections to manufacturer's recommended torque settings.

3.05 CLEANING
   A. Clean dirt and debris from switch enclosures and components according to manufacturer's instructions.
   B. Repair scratched or marred exterior surfaces to match original factory finish.

END OF SECTION
SELECTION 26 51 00
INTERIOR LIGHTING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Interior luminaires.
B. Emergency lighting units.
C. Exit signs.
D. Ballasts.
E. Lamps.
F. Luminaire accessories.

1.02 RELATED REQUIREMENTS

A. Section 26 05 37 - Boxes.
B. Section 26 05 53 - Identification for Electrical Systems: Identification products and requirements.
C. Section 26 09 23 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
D. Section 26 27 26 - Wiring Devices: Manual wall switches and wall dimmers.
E. Section 26 56 00 - Exterior Lighting.

1.03 REFERENCE STANDARDS

C. ANSI C82.4 - American National Standard for Lamp Ballasts - Ballasts for High-Intensity-Discharge and Low-Pressure Sodium Lamps.
D. ANSI C82.11 - American National Standard for Lamp Ballasts - High Frequency Fluorescent Lamp Ballasts.
E. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
H. NECA 1 - Standard for Good Workmanship in Electrical Construction.
I. NECA/IESNA 500 - Standard for Installing Indoor Lighting Systems.
K. NEMA WD 6 - Wiring Devices - Dimensional Requirements; National Electrical Manufacturers Association.
L. NFPA 70 - National Electrical Code.
N. UL 924 - Emergency Lighting and Power Equipment.
O. UL 935 - Fluorescent-Lamp Ballasts.
P. UL 1598 - Luminaires.
Q. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
   2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
   3. Coordinate the placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility installed under other sections or by others.
   4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Shop Drawings:
   1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
   2. Provide photometric calculations where luminaires are proposed for substitution upon request.
C. Shop Drawings: Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
D. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
      b. Include IES LM-79 test report upon request.
E. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.
F. Field Quality Control Reports.
G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
H. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.
   2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
   3. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.
4. Extra Ballasts: Two percent of total quantity installed for each type, but not less than one of each type.

J. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

1.06 QUALITY ASSURANCE

A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Conform to requirements of NFPA 70 and NFPA 101.
D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.

1.07 DELIVERY, STORAGE, AND PROTECTION

A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.08 FIELD CONDITIONS

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.09 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

1.10 EXTRA MATERIALS

A. See Section 01 6000 - Product Requirements, for additional provisions.
B. Furnish two of each plastic lens type.
C. Furnish one replacement lamps for each lamp type.
D. Furnish two of each ballast type.

PART 2 PRODUCTS

2.01 MANUFACTURERS

E. Columbia Lighting.
F. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LUMINAIRES

A. Manufacturers:
   2. Cooper Lighting, a division of Cooper Industries; www.cooperindustries.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Provide products that comply with requirements of NFPA 70.
C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
D. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, ballasts, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.

F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc. as necessary for a complete operating system.

G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.

H. LED Luminaires:
   1. Components: UL 8750 recognized or listed as applicable.
   2. Tested in accordance with IES LM-79 and IES LM-80.
   3. LED Estimated Useful Life: Minimum of 200,000 hours at 70 percent lumen maintenance, calculated based on IES LM-80 test data.

I. LED Luminaires: Listed and labeled as complying with UL 8750.

J. Track Lighting Systems: Provide track compatible with specified track heads, with all connectors, power feed fittings, dead ends, hangers and canopies as necessary to complete installation.

K. Luminaires Mounted in Continuous Rows: Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.03 EMERGENCY LIGHTING UNITS

A. Manufacturers:
   2. Cooper Lighting, a division of Cooper Industries; www.cooperindustries.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.

B. Description: Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924. Emergency and Exit light combination unit with (2) unit mounted lamps and LED exit light with battery backup. This combination unit shall have spare capacity to power remote emergency lamp heads.

C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.

D. Battery:
   1. Sealed maintenance-free nickel cadmium unless otherwise indicated.
   2. Size battery to supply all connected lamps, including emergency remote heads where indicated.

E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.

F. Provide low-voltage disconnect to prevent battery damage from deep discharge.

G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
H. Accessories:
   1. Provide compatible accessory mounting brackets where indicated or required to complete installation.
   2. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
   3. Provide compatible accessory wire guards where indicated.
   4. Where indicated, provide emergency remote heads that are compatible with the emergency lighting unit they are connected to and suitable for the installed location.

2.04 LUMINAIRES
   A. Furnish products as indicated in Schedule attached to this section.
   B. Substitutions: See Section 01 60 00 - Product Requirements.
      1. Input Voltage: 120 or 277 volts.

2.05 EXIT SIGNS
   A. Manufacturers:
      2. Cooper Lighting, a division of Cooper Industries; www.cooperindustries.com/#sle.
      4. Substitutions: See Section 01 60 00 - Product Requirements.
   B. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
      1. Number of Faces: Single or double as indicated or as required for the installed location.
      2. Directional Arrows: As indicated or as required for the installed location.
   C. Self-Powered Exit Signs:
      1. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
      2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
      3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
      4. Provide low-voltage disconnect to prevent battery damage from deep discharge.
      5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
   D. Accessories:
      1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
      2. Provide compatible accessory wire guards where indicated.
   E. Manufacturers: As indicated on lighting fixture schedule.
      1. Substitutions: See Section 01 60 00 - Product Requirements.
   F. Exit Signs: Exit sign fixture.
      2. Face: Translucent glass face with red letters on white background.
      3. Face: Aluminum stencil face with red letters.
      4. Directional Arrows: Universal type for field adjustment.
      5. Mounting: Universal, for field selection.
      6. Battery: 12 volt, nickel-cadmium type, with 1.5 hour capacity.
      7. Battery Charger: Dual-rate type, with sufficient capacity to recharge discharged battery to full charge within twelve hours.
8. Lamps: Manufacturer's standard.

2.06 BALLASTS

A. Manufacturers:
2. Osram Sylvania; www.sylvania.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.
5. Manufacturer Limitations: Where possible, for each type of luminaire provide ballasts produced by a single manufacturer.

B. All Ballasts:
1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

C. Fluorescent Ballasts:
1. All Fluorescent Ballasts: Unless otherwise indicated, provide high frequency electronic ballasts complying with ANSI C82.11 and listed and labeled as complying with UL 935.
   a. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of plus or minus 10 percent.
   b. Total Harmonic Distortion: Not greater than 10 percent.
   c. Power Factor: Not less than 0.95.
   d. Thermal Protection: Listed and labeled as UL Class P, with automatic reset for integral thermal protectors.
   e. Sound Rating: Class A, suitable for average ambient noise level of 20 to 24 decibels.
   f. Lamp Compatibility: Specifically designed for use with the specified lamp, with no visible flicker.
   g. Lamp Operating Frequency: Greater than 20 kHz, except as specified below.
      1) Do not operate lamp(s) within the frequencies from 30 kHz through 40 kHz in order to avoid interference with infrared devices.
   h. Lamp Current Crest Factor: Not greater than 1.7.
   i. Provide automatic restart capability to restart replaced lamp(s) without requiring resetting of power.
   j. Provide end of lamp life automatic shut down circuitry for T5 and smaller diameter lamp ballasts.
   k. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.
   l. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 18, for Class A, non-consumer application.
   m. Provide high efficiency T8 lamp ballasts certified as NEMA premium where indicated.
   n. Ballast Marking: Include wiring diagrams with lamp connections.
2. Non-Dimming Fluorescent Ballasts:
   a. Lamp Starting Method:
      1) T8 Lamp Ballasts: Programmed start unless otherwise indicated.
      2) T5 Lamp Ballasts: Programmed start unless otherwise indicated.
      3) Compact Fluorescent Lamp Ballasts: Programmed start unless otherwise indicated.
   b. Lamp Starting Temperature: Capable of starting standard lamp(s) at a minimum of 0 degrees F, and energy saving lamp(s) at a minimum of 60 degrees F unless otherwise indicated.
2.07 LAMPS

A. Manufacturers:
   2. Osram Sylvania; [www.sylvania.com/#sle].
   3. Philips Lighting Company; [www.lighting.philips.com].
   4. Philips Lighting Co of NA: [www.lighting.philips.com].
   5. Substitutions: See Section 01 60 00 - Product Requirements.

B. All Lamps:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

C. Compact Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
   1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.
   2. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
   3. Color Rendering Index (CRI): Not less than 80.
   4. Average Rated Life: Not less than 10,000 hours for an operating cycle of three hours per start.

D. Linear Fluorescent Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.
   1. Low Mercury Content: Provide lamps that pass the EPA Toxicity Characteristic Leaching Procedure (TCLP) test for characteristic hazardous waste.
   2. T8 Linear Fluorescent Lamps:
      a. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
      b. Color Rendering Index (CRI): Not less than 80.
      c. Average Rated Life: Not less than 20,000 hours for an operating cycle of three hours per start.
   3. T5 Linear Fluorescent Lamps:
      a. Correlated Color Temperature (CCT): 3,500 K unless otherwise indicated.
      b. Color Rendering Index (CRI): Not less than 80.
      c. Average Rated Life: Not less than 20,000 hours for an operating cycle of three hours per start.

E. Lamp Types: As specified for each luminaire.

F. Fluorescent Lamps:
   1. Product: Phillips Lighting - Type T5 or T8.
   2. Substitutions: See Section 01 60 00 - Product Requirements.

G. High Intensity Discharge (HID) Lamps:
   1. Product: Match Lighting Fixture Type
   2. Substitutions: See Section 01 60 00 - Product Requirements.

2.08 ACCESSORIES

A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
B. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4" size, field-painted as directed.
C. Provide accessory plaster frames for luminaires recessed in plaster ceilings.
D. Tube Guards for Linear Fluorescent Lamps: Provide clear virgin polycarbonate sleeves with endcaps where indicated.
E. Product: As indicated in lighting fixture schedule.
   1. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that field measurements are as shown on the drawings.
B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
C. Verify that suitable support frames are installed where required.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION
A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
B. Install products according to manufacturer's instructions.
C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship), NECA 500 (commercial lighting), and NECA 502 (industrial lighting).
D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
E. Suspended Ceiling Mounted Luminaires:
   1. Do not use ceiling tiles to bear weight of luminaires.
   2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
   3. Secure pendant-mounted luminaires to building structure.
   4. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
   5. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
   6. See appropriate Division 9 section where suspended grid ceiling is specified for additional requirements.
F. Recessed Luminaires:
   1. Install trims tight to mounting surface with no visible light leakage.
   2. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
   3. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
G. Suspended Luminaires:
   1. Install using the suspension method indicated, with support lengths and accessories as
      required for specified mounting height.
   2. Install canopies tight to mounting surface.

H. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to
   center of luminaire.

I. Install fixtures securely, in a neat and workmanlike manner, as specified in NECA 500
   (commercial lighting).

J. Install suspended luminaires and exit signs using pendants supported from swivel hangers.
   Provide pendant length required to suspend luminaire at indicated height.

K. Support luminaires independent of ceiling framing.

L. Locate recessed ceiling luminaires as indicated on reflected ceiling plan.

M. Install surface mounted luminaires and exit signs plumb and adjust to align with building lines
   and with each other. Secure to prevent movement.

N. Exposed Grid Ceilings: Support surface mounted luminaires in grid ceiling directly from
   building structure.

O. Exposed Grid Ceilings: Provide auxiliary members spanning ceiling grid members to support
   surface mounted luminaires.

P. Exposed Grid Ceilings: Fasten surface mounted luminaires to ceiling grid members using
   bolts, screws, rivets, or suitable clips.

Q. Install recessed luminaires to permit removal from below.

R. Install recessed luminaires using accessories and firestopping materials to meet regulatory
   requirements for fire rating.

S. Install clips to secure recessed grid-supported luminaires in place.

T. Install wall mounted luminaires, emergency lighting units, and exit signs at height as scheduled.

U. Install accessories furnished with each luminaire.

V. Make wiring connections to branch circuit using building wire with insulation suitable for
   temperature conditions within luminaire.

W. Bond products and metal accessories to branch circuit equipment grounding conductor.

X. Install specified lamps in each emergency lighting unit, exit sign, and luminaire.

Y. Air Handling Luminaires: Interface with air handling accessories furnished and installed under
   Section 23 36 00.

Z. Emergency Lighting Units:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding
      normal lighting in same room or area. Bypass local switches, contactors, or other lighting
      controls.

AA. Exit Signs:
   1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding
      normal lighting in same room or area. Bypass local switches, contactors, or other lighting
      controls.

AB. Install lamps in each luminaire.

AC. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's
   recommendations prior to use with any dimming controls. Replace lamps that fail prematurely
   due to improper lamp burn-in.
3.04 FIELD QUALITY CONTROL

A. See Section 01 40 00 - Quality Requirements, for additional requirements.
B. Inspect each product for damage and defects.
C. Perform field inspection, testing, and adjusting in accordance with Section 01 4000.
D. Operate each luminaire after installation and connection to verify proper operation.
E. Test self-powered exit signs, emergency lighting units, and fluorescent emergency power supply units to verify proper operation upon loss of normal power supply.
F. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.
B. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.
D. Aim and adjust luminaires as indicated.
E. Position exit sign directional arrows as indicated.

3.06 CLEANING

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer’s instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
B. Clean electrical parts to remove conductive and deleterious materials.
C. Remove dirt and debris from enclosures.
D. Clean photometric control surfaces as recommended by manufacturer.
E. Clean finishes and touch up damage.

3.07 CLOSEOUT ACTIVITIES

A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
B. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION

A. Protect installed luminaires from subsequent construction operations.

3.09 PROTECTION

A. Relamp luminaires that have failed lamps at Substantial Completion.

3.10 SCHEDULE - ATTACHED

END OF SECTION
PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Exterior luminaires.
   B. Ballasts.
   C. Lamps.
   D. Poles and accessories.
   E. Luminaire accessories.

1.02 RELATED REQUIREMENTS
   A. Section 03 30 00 - Cast-in-Place Concrete: Materials and installation requirements for concrete bases for poles.
   B. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
   C. Section 26 05 37 - Boxes.
   D. Section 26 27 26 - Wiring Devices: Receptacles for installation in poles.
   E. Section 26 28 13 - Fuses.
   F. Section 26 51 00 - Interior Lighting.

1.03 REFERENCE STANDARDS
   B. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
   D. IESNA LM-64 - Photometric Measurements of Parking Areas.
   E. NECA 1 - Standard for Good Workmanship in Electrical Construction.
   G. NFPA 70 - National Electrical Code.
   H. UL 1598 - Luminaires.
   I. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.04 ADMINISTRATIVE REQUIREMENTS
   A. Coordination:
      1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under other sections or by others. Coordinate elevation to obtain specified foundation height.
      2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Shop Drawings:
      1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
      2. Provide photometric calculations where luminaires are proposed for substitution.
C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, weight, effective projected area (EPA), and installed accessories; include model number nomenclature clearly marked with all proposed features.
   1. LED Luminaires:
      a. Include estimated useful life, calculated based on IES LM-80 test data.
   2. Provide electronic files of photometric data certified by a National Voluntary Laboratory Accreditation Program (NVLAP) lab or independent testing agency in IESNA LM-63 standard format upon request.
   3. Lamps: Include rated life and initial and mean lumen output.
   4. Poles: Include information on maximum supported effective projected area (EPA) and weight for the design wind speed.

D. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.

E. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.

F. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.

G. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
   1. See Section 01 60 00 - Product Requirements, for additional provisions.

I. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.

1.06 QUALITY ASSURANCE
A. Conform to requirements of NFPA 70.
B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Receive, handle, and store products according to NECA/IESNA 501 and manufacturer's written instructions.
B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.
C. Receive, handle, and store wood poles in accordance with ANSI O5.1.

1.08 WARRANTY
A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
PART 2 PRODUCTS

2.01 MANUFACTURERS
C. Substitutions: See Section 01 60 00 - Product Requirements.

2.02 LUMINAIRE TYPES
A. Furnish products as indicated in luminaire schedule included on the Drawings.
B. Substitutions: See Section 01 60 00 - Product Requirements.

2.03 LUMINAIRES
A. Manufacturers:
   2. Cooper Lighting, a division of Cooper Industries; www.cooperindustries.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. Provide products that comply with requirements of NFPA 70.
C. Provide products that are listed and labeled as complying with UL 1598, where applicable.
D. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
E. Unless otherwise indicated, provide complete luminaires including lamp(s) and all sockets, reflectors, lenses, housings and other components required to position, energize and protect the lamp and distribute the light.
F. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, poles, foundations, supports, trims, accessories, etc. as necessary for a complete operating system.
G. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
H. Provide luminaires listed and labeled as suitable for wet locations unless otherwise indicated.
I. LED Luminaires: Listed and labeled as complying with UL 8750.
J. Exposed Hardware: Stainless steel.

2.04 BALLASTS
A. Manufacturers:
   2. Osram Sylvania; www.sylvania.com/#sle.
   4. Substitutions: See Section 01 60 00 - Product Requirements.
B. All Ballasts:
   1. Provide ballasts containing no polychlorinated biphenyls (PCBs).
   2. Minimum Efficiency/Efficacy: Provide ballasts complying with all current applicable federal and state ballast efficiency/efficacy standards.

2.05 LAMPS
A. Manufacturers:
   2. Osram Sylvania; www.sylvania.com/#sle.
4. Substitutions: See Section 01 60 00 - Product Requirements.

B. All Lamps:
   1. Unless explicitly excluded, provide new, compatible, operable lamps in each luminaire.
   2. Verify compatibility of specified lamps with luminaires to be installed. Where lamps are not specified, provide lamps per luminaire manufacturer's recommendations.
   3. Minimum Efficiency: Provide lamps complying with all current applicable federal and state lamp efficiency standards.
   4. Color Temperature Consistency: Unless otherwise indicated, for each type of lamp furnish products which are consistent in perceived color temperature. Replace lamps that are determined by the Architect to be inconsistent in perceived color temperature.

2.06 ACCESSORIES
   A. Stems for Suspended Luminaires: Steel tubing, minimum 1/2" size, factory finished to match luminaire or field-painted as directed.
   B. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that field measurements are as shown on the drawings.
   B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
   C. Verify that suitable support frames are installed where required.
   D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
   E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION
   A. Provide extension rings to bring outlet boxes flush with finished surface.
   B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION
   A. Coordinate locations of outlet boxes provided under Section 26 05 37 as required for installation of luminaires provided under this section.
   B. Install products according to manufacturer's instructions.
   C. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 1 (general workmanship) and NECA/IESNA 501 (exterior lighting).
   D. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
   E. Recessed Luminaires:
      1. Install trims tight to mounting surface with no visible light leakage.
      2. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
   F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
   G. Install accessories furnished with each luminaire.
   H. Bond products and metal accessories to branch circuit equipment grounding conductor.
   I. Install lamps in each luminaire.
3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Inspect each product for damage and defects.
   C. Operate each luminaire after installation and connection to verify proper operation.
   D. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

3.05 ADJUSTING
   A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Architect. Secure locking fittings in place.

3.06 CLEANING
   A. Clean surfaces according to NECA/IESNA 501 and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES
   A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
   B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
   C. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
   D. Just prior to Substantial Completion, replace all lamps that have failed.

3.08 PROTECTION
   A. Protect installed luminaires from subsequent construction operations.

END OF SECTION
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SECTION 27 10 05
STRUCTURED CABLELING FOR VOICE AND DATA - INSIDE-PLANT

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Communications system design requirements.
B. Copper cable and terminations.
C. Communications identification.

1.02 REFERENCE STANDARDS
A. NFPA 70 - National Electrical Code.
B. TIA-568.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
C. TIA-606 - Administration Standard for Telecommunications Infrastructure.
D. TIA-607-C - Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
E. UL 444 - Communications Cables.
F. UL 1863 - Communications-Circuit Accessories.

1.03 ADMINISTRATIVE REQUIREMENTS
A. Coordination:
   1. Coordinate the work with other trades to avoid placement of other utilities or obstructions within the spaces dedicated for communications equipment.
   2. Coordinate arrangement of communications equipment with the dimensions and clearance requirements of the actual equipment to be installed.
   3. Notify Architect/Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
   4. Coordinate requirements of this section with Owner.

1.04 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
C. Shop Drawings: Show compliance with requirements on isometric schematic diagram of network layout, showing cable routings, telecommunication closets, rack and enclosure layouts and locations, service entrance, and grounding, prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
D. Evidence of qualifications for installer.
E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and operation of product.
F. Field Test Reports.
G. Project Record Documents: Prepared and approved by BICSI Registered Communications Distribution Designer (RCDD).
   1. Record actual locations of outlet boxes and distribution frames.
   2. Show as-installed color coding, pair assignment, polarization, and cross-connect layout.
   3. Identify distribution frames and equipment rooms by room number on contract drawings.
1.05 QUALITY ASSURANCE
   A. Manufacturer Qualifications: At least 3 years experience manufacturing products of the type specified.
   B. Installer Qualifications: A company having at least 3 years experience in the installation and testing of the type of system specified, and:
      1. Supervisors and installers factory certified by manufacturers of products to be installed.
   C. Products: Listed, classified, and labeled as suitable for the purpose intended.

1.06 DELIVERY, STORAGE, AND HANDLING
   A. Store products in manufacturer's unopened packaging until ready for installation.
   B. Keep stored products clean and dry.

1.07 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Correct defective Work within a 2 year period after Date of Substantial Completion.
   C. Provide warranty as called out in applicable referenced State of Delaware standards/specifications

PART 2 PRODUCTS

2.01 SYSTEM DESIGN
   A. Provide a complete permanent system of cabling and pathways for voice and data communications, including cables, conduits and wireways, pull wires, support structures, enclosures and cabinets, and outlets.
   B. IMPORTANT!! PLEASE NOTE THAT this specification references the Delaware State-Wide Information And Architecture Standards, Standard ID: NE=Cabling-002, Title: Structured Cabling System Standards and Specifications for State-Managed Facilities, Domain: Network and Storage, Discipline: Cabling, Revision Date: 1/29/2021, Revision no.: 8, Original date: 7/21/2008. As such this document shall be considered as part of this specification. Unless otherwise shown and or specified, all work, materials, etc. called for in the above mentioned document shall be provided as shown and specified the above mentioned document and on the drawings.

2.02 COPPER CABLE AND TERMINATIONS
   A. Copper Horizontal Cable:
      1. Description: 100 ohm, balanced twisted pair cable complying with TIA-568.2 and listed and labeled as complying with UL 444.
      2. Cable Type - Data: TIA-568.2 Category 6 UTP (unshielded twisted pair); 23 AWG.
      3. Cable Capacity: 4-pair.
      4. Cable Applications:
         a. Use listed NFPA 70 Type CMP plenum cable for all applications
      5. Cable Jacket color - See Drawings
   B. Copper Cable Terminations: Insulation displacement connection (IDC) type using appropriate tool; use screw connections only where specifically indicated.
   C. Jacks and Connectors: Modular RJ-45, non-keyed, terminated with 110-style insulation displacement connectors (IDC); high impact thermoplastic housing; suitable for and complying with same standard as specified horizontal cable; UL 1863 listed.
      1. Performance: 500 mating cycles.
      2. Voice and Data Jacks: 8-position modular jack, color-coded for both T568A and T568B wiring configurations.
2.03 IDENTIFICATION PRODUCTS
   A. Comply with TIA-606.
   B. Identification shall be as specified and directed by Owner at no additional cost to the Owner

PART 3 EXECUTION
3.01 INSTALLATION - GENERAL
   A. Comply with Communication Service Provider requirements.
   B. Grounding and Bonding: Perform in accordance with TIA-607-C and NFPA 70.
   C. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07 84 00.

3.02 INSTALLATION OF PATHWAYS
   A. Cabling shall pass from MDF or IDFs into corridors using the most direct pathway possible. Cabling shall be run from corridors into spaces served/terminated at outlets. In no cases shall cabling be run from space to space without prior approval by the Architect/Engineer.

3.03 INSTALLATION OF EQUIPMENT AND CABLING
   A. Cabling:
      1. Do not bend cable at radius less than manufacturer's recommended bend radius; for unshielded twisted pair use bend radius of not less than 4 times cable diameter.
      2. Do not over-cinch or crush cables.
      3. Do not exceed manufacturer's recommended cable pull tension.
      4. When installing in conduit, use only lubricants approved by cable manufacturer and do not chafe or damage outer jacket.
   B. Copper Cabling:
      1. Category 5e and Above: Maintain cable geometry; do not untwist more than 1/2 inch from point of termination.
      2. For 4-pair cables in conduit, do not exceed 25 pounds pull tension.
      3. Use T568B wiring configuration.
   C. Identification:
      1. Use wire and cable markers to identify cables at each end.
      2. Identify components as directed by Owner at no additional cost to Owner.

3.04 FIELD QUALITY CONTROL
   A. See Section 01 40 00 - Quality Requirements, for additional requirements.
   B. Comply with inspection and testing requirements of specified installation standards.
   C. Visual Inspection:
      1. Inspect cable jackets for certification markings.
      2. Inspect cable terminations for color coded labels of proper type.
      3. Inspect outlet plates and patch panels for complete labels.
   D. Testing - Copper Cabling and Associated Equipment: Test cabling in accordance with above mentioned standards in system design.

END OF SECTION
PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Fire alarm system design and installation, including all components, wiring, and conduit.
   B. Replacement and removal of existing fire alarm system components, wiring, and conduit indicated.
   C. Maintenance of fire alarm system under contract for specified warranty period.
1.02 RELATED REQUIREMENTS
   A. Section 07 84 00 - Firestopping: Materials and methods for work to be performed by this installer.
   B. Section 08 71 00 - Door Hardware: Electrically operated locks and door holder devices to be monitored and released by fire alarm system.
   C. Section 21 13 00 - Fire Suppression Sprinkler Systems: Supervisory, alarm, and actuating devices installed in sprinkler system.
   D. Section 23 33 00 - Air Duct Accessories: Smoke dampers monitored and controlled by fire alarm system.
1.03 REFERENCE STANDARDS
   B. ADA Standards - 2010 ADA Standards for Accessible Design.
   C. IEEE C62.41.2 - IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
   D. NFPA 70 - National Electrical Code.
   E. NFPA 72 - National Fire Alarm and Signaling Code.
1.04 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Proposal Documents: Submit the following with cost/time proposal:
      1. NFPA 72 "Record of Completion", filled out to the extent known at the time.
      2. Manufacturer's detailed data sheet for each control unit, initiating device, and notification appliance.
      3. Certification by Contractor that the system design will comply with Contract Documents.
   C. Drawings must be prepared Revit 2019.
      1. Owner will provide floor plan drawings for Contractor's use; verify all dimensions on Owner-provided drawings.
   D. Evidence of designer qualifications.
   E. Design Documents: Submit all information required for plan review and permitting by authorities having jurisdiction, including but not limited to floor plans, riser diagrams, and description of operation:
      1. Copy (if any) of list of data required by authority having jurisdiction.
2. NFPA 72 "Record of Completion", filled out to the extent known at the time.
3. Clear and concise description of operation, with input/output matrix similar to that shown in NFPA 72 Appendix A-7-5-2.2(9), and complete listing of software required.
4. System zone boundaries and interfaces to fire safety systems.
5. Location of all components, circuits, and raceways; mark components with identifiers used in control unit programming.
6. Circuit layouts; number, size, and type of raceways and conductors; conduit fill calculations; spare capacity calculations; notification appliance circuit voltage drop calculations.
7. List of all devices on each signaling line circuit, with spare capacity indicated.
8. Manufacturer's detailed data sheet for each component, including wiring diagrams, installation instructions, and circuit length limitations.
9. Description of power supplies; if secondary power is by battery include calculations demonstrating adequate battery power.
10. Certification by either the manufacturer of the control unit or by the manufacturer of each other component that the components are compatible with the control unit.
11. Certification by the manufacturer of the control unit that the system design complies with Contract Documents.
12. Certification by Contractor that the system design complies with Contract Documents.
13. Do not show existing components to be removed.

F. Manufacturer's equipment seismic qualification certification.

G. Evidence of installer qualifications.

H. Evidence of instructor qualifications; training lesson plan outline.

I. Evidence of maintenance contractor qualifications, if different from installer.

J. Inspection and Test Reports:
   1. Submit inspection and test plan prior to closeout demonstration.
   2. Submit documentation of satisfactory inspections and tests.
   3. Submit NFPA 72 "Inspection and Test Form," filled out.

K. Operating and Maintenance Data: See Section 01 78 00 for additional requirements; revise and resubmit until acceptable; have one set available during closeout demonstration:
   1. Complete set of specified design documents, as approved by authority having jurisdiction.
   2. Additional printed set of project record documents and closeout documents, bound or filed in same manuals.
   3. Contact information for firm that will be providing contract maintenance and trouble call-back service.
   4. List of recommended spare parts, tools, and instruments for testing.
   5. Replacement parts list with current prices, and source of supply.
   6. Detailed troubleshooting guide and large scale input/output matrix.
   7. Preventive maintenance, inspection, and testing schedule complying with NFPA 72; provide printed copy and computer format acceptable to Owner.
   8. Detailed but easy to read explanation of procedures to be taken by non-technical administrative personnel in the event of system trouble, when routine testing is being conducted, for fire drills, and when entering into contracts for remodeling.

L. Project Record Documents: See Section 01 78 00 for additional requirements; have one set available during closeout demonstration:
   1. Complete set of floor plans showing actual installed locations of components, conduit, and zones.
   2. "As installed" wiring and schematic diagrams, with final terminal identifications.
3. "As programmed" operating sequences, including control events by device, updated input/output chart, and voice messages by event.

M. Closeout Documents:
   1. Certification by manufacturer that the system has been installed in compliance with manufacturer's installation requirements, is complete, and is in satisfactory operating condition.
   2. NFPA 72 "Record of Completion", filled out completely and signed by installer and authorized representative of authority having jurisdiction.

N. Maintenance Materials, Tools, and Software: Furnish the following for Owner's use in maintenance of project.
   1. Furnish spare parts of same manufacturer and model as those installed; deliver in original packaging, labeled in same manner as in operating and maintenance data and place in spare parts cabinet.

1.05 QUALITY ASSURANCE

A. Designer Qualifications: NICET Level III or IV (3 or 4) certified fire alarm technician or registered fire protection engineer, employed by fire alarm control panel manufacturer, Contractor, or installer, with experience designing fire alarm systems in the jurisdictional area of the authorities having jurisdiction.

B. Installer Qualifications: Firm with minimum 3 years documented experience installing fire alarm systems of the specified type and providing contract maintenance service as a regular part of their business.
   1. Authorized representative of control unit manufacturer; submit manufacturer's certification that installer is authorized; include name and title of manufacturer's representative making certification.
   2. Installer Personnel: At least 2 years of experience installing fire alarm systems.
   3. Supervisor: NICET level III or IV (3 or 4) certified fire alarm technician; furnish name and address.

C. Maintenance Contractor Qualifications: Same entity as installer or different entity with specified qualifications.

D. Instructor Qualifications: Experienced in technical instruction, understanding fire alarm theory, and able to provide the required training; trained by fire alarm control unit manufacturer.

E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.06 WARRANTY

A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.

B. Provide control panel manufacturer's warranty that system components other than wire and conduit are free from defects and will remain so for 1 year after date of Substantial Completion.

C. Provide installer's warranty that the installation is free from defects and will remain so for 1 year after date of Substantial Completion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Fire Alarm Control Units and Accessories - Basis of Design: EST.

B. Fire Alarm Control Units and Accessories - Other Acceptable Manufacturers:
   1. Provide control units made by the same manufacturer.

C. Initiating Devices and Notification Appliances:
1. Same manufacturer as control units.
2. Provide initiating devices and notification appliances made by the same manufacturer, where possible.

D. Substitutions: See Section 01 60 00 - Product Requirements.
   1. For other acceptable manufacturers of control units specified, submit product data showing equivalent features and compliance with Contract Documents.
   2. For substitution of products by manufacturers not listed, submit product data showing features and certification by Contractor that the design will comply with Contract Documents.

2.02 FIRE ALARM SYSTEM

A. Fire Alarm System: Provide modifications and extensions to the existing automatic fire detection and alarm system:
   1. Provide all components necessary, regardless of whether shown in Contract Documents or not.
   2. Protected Premises: Entire building shown on drawings.
   3. Comply with the following; where requirements conflict, order of precedence of requirements is as listed:
      a. ADA Standards.
      b. The requirements of the State Fire Marshal.
      c. Applicable local codes.
      d. Contract Documents (drawings and specifications).
      e. NFPA 101.
      f. NFPA 72; where the word "should" is used consider that provision mandatory; where conflicts between requirements require deviation from NFPA 72, identify deviations clearly on design documents.
   4. Evacuation Alarm: Multiple smoke zones; allow for evacuation notification of any individual zone or combination of zones, in addition to general evacuation of entire premises.
   6. General Evacuation Zones: Each smoke zone is considered a general evacuation zone unless otherwise indicated, with alarm notification in all zones on the same floor, on the floor above, and the floor below.
   7. Program notification zones and voice messages as directed by Owner.
   8. Fire Command Center: Location indicated on drawings.

B. Supervising Stations and Fire Department Connections:
   1. Public Fire Department Notification: By on-premises supervising station.
   2. Auxiliary Connection Type: Local energy.

C. Circuits:
   1. Initiating Device Circuits (IDC): Class B, Style A.
   2. Signaling Line Circuits (SLC) Within Single Building: Class B, Style 0.5.
   3. Notification Appliance Circuits (NAC): Class B, Style W.

D. Spare Capacity:
   1. Initiating Device Circuits: Minimum 25 percent spare capacity.
   4. Fire Alarm Control Units: Capable of handling all circuits utilized to capacity without requiring additional components other than plug-in control modules.
E. Power Sources:
   1. Primary: Dedicated branch circuits of the facility power distribution system.
   2. Secondary: Storage batteries.
   3. Capacity: Sufficient to operate entire system for period specified by NFPA 72.

2.03 EXISTING COMPONENTS
A. Existing Fire Alarm System: Remove existing components indicated and incorporate remaining components into new system, under warranty as if they were new; do not take existing portions of system out of service until new portions are fully operational, tested, and connected to existing system.
B. Clearly label components that are "Not In Service."
C. Remove unused existing components and materials from site and dispose of properly.

2.04 FIRE SAFETY SYSTEMS INTERFACES
A. Supervision: Provide supervisory signals in accordance with NFPA 72 for the following:
   1. Sprinkler water control valves.
   2. Dry-pipe sprinkler system pressure.
   3. Dry-pipe sprinkler valve room low temperature.
B. Alarm: Provide alarm initiation in accordance with NFPA 72 for the following:
   1. Sprinkler water flow.
   2. Duct smoke detectors.
C. HVAC:
   1. Duct Smoke Detectors: Close dampers indicated; shut down air handlers indicated.
D. Doors:
   1. Electromagnetic Door Locks on Egress Doors: Unlock upon activation of any alarm initiating device or suppression system in smoke zone that doors serve as egress from. Refer to Section 08 71 00.

2.05 COMPONENTS
A. General:
   1. Provide flush mounted units where installed in finish areas; in unfinished areas, surface mounted unit are acceptable.
   2. Provide legible, permanent labels for each control device, using identification used in operation and maintenance data.
B. Fire Alarm Control Units: Analog, addressable type; listed, classified, and labeled as suitable for the purpose intended.
C. Master Control Unit: As specified for Basis of Design above, or equivalent.
D. Initiating Devices:
   1. Addressable Systems:
      a. Addressable Devices: Individually identifiable by addressable fire alarm control unit.
      b. Provide suitable addressable interface modules as indicated or as required for connection to conventional (non-addressable) devices and other components that provide a dry closure output.
      a. Provide 1 extra.
   3. Smoke Detectors: EST.
      a. Provide 1 extra.
   4. Duct Smoke Detectors: EST.
a. Provide 1 extra.

5. Heat Detectors: EST.
   a. Provide 1 extra.

E. Notification Appliances:
   1. Speakers: EST.
      a. Provide 1 extra.
   2. Strobes: EST.
      a. Provide 1 extra.

F. Circuit Conductors: Copper or optical fiber; provide 200 feet extra; color code and label.

G. Surge Protection: In accordance with IEEE C62.41.2 category B combination waveform and NFPA 70; except for optical fiber conductors.

H. Locks and Keys: Deliver keys to Owner.

I. Instruction Charts: Printed instruction chart for operators, showing steps to be taken when a signal is received (normal, alarm, supervisory, and trouble); easily readable from normal operator's station.
   1. Frame: Stainless steel or aluminum with polycarbonate or glass cover.
   2. Provide one for each control unit where operations are to be performed.
   3. Obtain approval of Owner prior to mounting; mount in location acceptable to Owner.
   4. Provide extra copy with operation and maintenance data submittal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with applicable codes, NFPA 72, NFPA 70, and Contract Documents.

B. Conceal all wiring, conduit, boxes, and supports where installed in finished areas.

C. Obtain Owner's approval of locations of devices, before installation.

D. Install instruction cards and labels.

3.02 INSPECTION AND TESTING FOR COMPLETION

A. Notify Owner 7 days prior to beginning completion inspections and tests.

B. Notify authorities having jurisdiction and comply with their requirements for scheduling inspections and tests and for observation by their personnel.

C. Provide the services of the installer's supervisor or person with equivalent qualifications to supervise inspection and testing, correction, and adjustments.

D. Prepare for testing by ensuring that all work is complete and correct; perform preliminary tests as required.

E. Provide all tools, software, and supplies required to accomplish inspection and testing.

F. Perform inspection and testing in accordance with NFPA 72 and requirements of local authorities; document each inspection and test.

G. Correct defective work, adjust for proper operation, and retest until entire system complies with Contract Documents.

H. Diagnostic Period: After successful completion of inspections and tests, operate system in normal mode for at least 14 days without any system or equipment malfunctions.
   1. Record all system operations and malfunctions.
   2. If a malfunction occurs, start diagnostic period over after correction of malfunction.
   3. Owner will provide attendant operator personnel during diagnostic period; schedule training to allow Owner personnel to perform normal duties.
4. At end of successful diagnostic period, fill out and submit NFPA 72 "Inspection and Testing Form."

3.03 OWNER PERSONNEL INSTRUCTION

A. Provide the following instruction to designated Owner personnel:

B. Administrative: One-hour session(s) covering issues necessary for non-technical administrative staff; classroom:
   1. Initial Training: 1 session pre-closeout.

C. Basic Operation: One-hour sessions for attendant personnel, security officers, and engineering staff; combination of classroom and hands-on:
   1. Initial Training: 1 session pre-closeout.

D. Furnish the services of instructors and teaching aids; have copies of operation and maintenance data available during instruction.

3.04 CLOSEOUT

A. Closeout Demonstration: Demonstrate proper operation of all functions to Owner.
   1. Be prepared to conduct any of the required tests.
   2. Have at least one copy of operation and maintenance data, preliminary copy of project record drawings, input/output matrix, and operator instruction chart(s) available during demonstration.
   3. Have authorized technical representative of control unit manufacturer present during demonstration.
   4. Demonstration may be combined with inspection and testing required by authority having jurisdiction; notify authority having jurisdiction in time to schedule demonstration.
   5. Repeat demonstration until successful.

END OF SECTION
PART 1  GENERAL

1.01  RELATED DOCUMENTS

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

1.02  SUMMARY

A. Section Includes:
   1. Excavating and filling for rough grading the Site.
   2. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
   3. Excavating and backfilling for buildings and structures.
   4. Drainage course for concrete slabs-on-grade.
   5. Subbase course for concrete walks and pavements.
   6. Subbase course and base course for asphalt paving.
   7. Subsurface drainage backfill for walls and trenches.
   8. Excavating and backfilling trenches for utilities and pits for buried utility structures.

B. Related Requirements:
   1. Section 01 32 00 "Construction Progress Documentation" for recording preexcavation and earth-moving progress.
   2. Civil Drawings for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
   3. Section 32 93 00 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.

1.03  DEFINITIONS

A. Backfill: Soil material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
   2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Engineer. Unauthorized excavation, as well as remedial work directed by Engineer, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and
pit excavation and exceed a standard penetration resistance of 100 blows/2 inches when
tested by a geotechnical testing agency, according to ASTM D1586. Rock material that cannot
be removed by rock-excavating equipment equivalent to the following in size and performance
ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic
   excavator; equipped with a 42-inch maximum-width, short-tip-radius rock bucket; rated at
   not less than 138-hp flywheel power with bucket-curving force of not less than 28,700 lbf
   and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.
2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than
   230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a
general-purpose bare bucket.
I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical
   and electrical appurtenances, or other man-made stationary features constructed above or
   below the ground surface.
J. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix
   asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete
   pavement or a cement concrete or hot-mix asphalt walk.
K. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill
   immediately below subbase, drainage fill, drainage course, or topsoil materials.
L. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground
   services within buildings.

1.04 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct preexcavation conference at Project site.
   1. Review methods and procedures related to earthmoving, including, but not limited to, the
      following:
      a. Personnel and equipment needed to make progress and avoid delays.
      b. Coordination of Work with utility locator service.
      c. Coordination of Work and equipment movement with the locations of tree- and
         plant-protection zones.
      d. Extent of trenching by hand or with air spade.
      e. Field quality control.

1.05 ACTION SUBMITTALS
A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.
   2. Warning tapes.
B. Samples for Verification: For the following products, in sizes indicated below:
   2. Warning Tape: 12 inches long; of each color.

1.06 INFORMATIONAL SUBMITTALS
A. Qualification Data: For qualified testing agency.
B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as
   follows:
   1. Classification according to ASTM D2487.
   2. Laboratory compaction curve according to ASTM D698.
C. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction
   and site improvements, including finish surfaces that might be misconstrued as damage
   caused by earth-moving operations. Submit before earth moving begins.
1.07 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

1.08 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without fifteen days of advanced notice and written permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
   1. Do not proceed with work on adjoining property until directed by Engineer. This includes any disruption to common sidewalk and drive aisle areas. Authorization will not be reasonable withheld.

C. Utility Locator Service: Notify "Miss Utility" of Delaware for area where Project is located before beginning earth-moving operations.

D. Do not commence earth-moving operations until erosion- and sedimentation-control measures specified on the Civil Drawings are in place.

E. Do not commence earth-moving operations until plant-protection measures are in place.

F. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

G. Do not direct vehicle or equipment exhaust towards protection zones.

H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

I. Do not allow contractor vehicles or equipment to be stored or parked on adjacent property or common areas without the express written consent of the Owner.

PART 2 PRODUCTS

2.01 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Soil Classification Groups GW, SW, SP, and SM according to ASTM D2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter. Soil Classification Groups SM, ML, and CL can be used with approval from owner’s testing and inspection agency if they do not contain organics.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.
1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve.

F. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.

H. Drainage Course: Narrowly graded mixture of washed crushed stone, or crushed or uncrushed gravel; ASTM D448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and zero to 5 percent passing a No. 8 sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and zero to 5 percent passing a No. 4 sieve.

J. Sand: ASTM C33; fine aggregate.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.02 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Survivability: As follows:
      a. Grab Tensile Strength: 157 lbf; ASTM D4632.
      b. Sewn Seam Strength: 142 lbf; ASTM D4632.
      c. Tear Strength: 56 lbf; ASTM D4533.
      d. Puncture Strength: 56 lbf; ASTM D4833.
   3. Apparent Opening Size: No. 40 sieve, maximum; ASTM D4751.
   4. Permittivity: 0.5 per second, minimum; ASTM D4491.
   5. UV Stability: 50 percent after 500 hours’ exposure; ASTM D4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
   1. Survivability: Class 2; AASHTO M 288.
   2. Survivability: As follows:
      a. Grab Tensile Strength: 247 lbf; ASTM D4632.
      b. Sewn Seam Strength: 222 lbf; ASTM D4632.
      c. Tear Strength: 90 lbf; ASTM D4533.
      d. Puncture Strength: 90 lbf; ASTM D4833.
   3. Apparent Opening Size: No. 60 sieve, maximum; ASTM D4751.
   4. Permittivity: 0.02 per second, minimum; ASTM D4491.
   5. UV Stability: 50 percent after 500 hours’ exposure; ASTM D4355.
2.03 ACCESSORIES

A. Warning Tape (For metallic pipe): Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility; colored as follows:
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

B. Detectable Warning Tape (For non-metallic pipe): Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils 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 deep; colored as follows:
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 EXECUTION

3.01 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.

B. Protect and maintain erosion and sedimentation controls during earth-moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.02 DEWATERING

A. Provide dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

E. Dewatering operations must comply with the Delaware Erosion and Sediment Control Handbook as amended.

3.03 EXPLOSIVES

A. Explosives: Do not use explosives.
3.04 EXCAVATION, GENERAL

A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Engineer. The Contract Sum will be adjusted for unsuitable soils and/or rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for additional excavation and replacement.
   1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.
      a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches outside of concrete forms other than at footings.
      b. 12 inches outside of concrete forms at footings.
      c. 6 inches outside of minimum required dimensions of concrete cast against grade.
      d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      e. 6 inches beneath bottom of concrete slabs-on-grade.
      f. 6 inches beneath pipe in trenches and the greater of 24 inches wider than pipe or 42 inches wide.

3.05 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
   1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
   2. Excavation for Underground Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:
   1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Cut and protect roots.

3.06 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.07 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.
1. Clearance: 12 inches each side of pipe or conduit or as indicated.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade. Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.
   1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
   2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
   3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
   4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trenches in Tree- and Plant-Protection Zones:
   1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-line spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
   2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.
   3. Cut and protect roots.

3.08 SUBGRADE INSPECTION
   A. Notify Engineer when excavations have reached required subgrade.
   B. If Engineer determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
   C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
      1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.
      2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Engineer, and replace with compacted backfill or fill as directed.
   D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
   E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

3.09 UNAUTHORIZED EXCAVATION
   A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Engineer.
      1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

3.10 STORAGE OF SOIL MATERIALS
   A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover or employ temporary stabilization to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL
A. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Installing permanent or temporary horizontal bracing on horizontally supported walls.
B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL
A. Place backfill on subgrades free of mud, frost, snow, or ice.
B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 3 Section "Cast-in-Place Concrete."
D. Trenches under Roadways: Provide 4-inch thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase course. Concrete is specified in Division 3 Section "Cast-in-Place Concrete."
E. Backfill voids with satisfactory soil while removing shoring and bracing.
F. Initial Backfill:
   1. Soil Backfill: Place and compact initial backfill of satisfactory soil, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
      a. Carefully compact initial backfill under pipe haunches and compact evenly upon both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.
G. Final Backfill:
   1. Soil Backfill: Place and compact final backfill of satisfactory soil to final subgrade elevation.
H. Warning Tape: Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.13 SOIL FILL
A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.
C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D698:
   1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches of existing subgrade and each layer of backfill or fill soil material at 95 percent.
   2. Under walkways, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 92 percent.
   3. Under turf or unpaved areas, scarify and recompact top 6 inches below subgrade and compact each layer of backfill or fill soil material at 85 percent.
   4. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch.
   2. Walks: Plus or minus 1 inch.
   3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 SUBSURFACE DRAINAGE

A. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
B. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
   1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D698 with a minimum of two passes of a plate-type vibratory compactor.
   2. Place and compact impervious fill over drainage backfill in 6-inch-thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS
A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
   1. Place base course material over subbase course under hot-mix asphalt pavement.
   2. Shape subbase course and base course to required crown elevations and cross-slope grades.
   3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
   4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (thick or less than 3 inches thick.
   5. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D698.
C. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.19 DRAINAGE COURSE UNDER CONCRETE SLABS-ON-GRADE
A. Place drainage course on subgrades free of mud, frost, snow, or ice.
B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Place drainage course in lifts not to exceed 6 inches.
   2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D698.

3.20 FIELD QUALITY CONTROL
A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material classification and maximum lift thickness comply with requirements.
   3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing
subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Engineer.

D. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
   1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab but in no case fewer than three tests.
   2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length but no fewer than two tests.
   3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length but no fewer than two tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION
   A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
   B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
      1. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
   C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
      1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS
   A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION
SECTION 31 31 16
TERMITE CONTROL

PART 1 GENERAL
1.01 SECTION INCLUDES
   A. Chemical soil treatment.

1.02 REFERENCE STANDARDS

1.03 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. Product Data: Indicate toxicants to be used, composition by percentage, dilution schedule, intended application rate.
   C. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements.

1.04 QUALITY ASSURANCE
   A. Installer Qualifications: Company specializing in performing this type of work and:
      1. Having minimum of three (3) years documented experience.
      2. Approved by manufacturer of treatment materials.
      3. Licensed in the State in which the Project is located.

PART 2 PRODUCTS
2.01 CHEMICAL SOIL TREATMENT
   A. Toxicant Chemical: EPA (Title 7, United States Code, 136 through 136y) approved; synthetically color dyed to permit visual identification of treated soil.
   B. Diluent: Recommended by toxicant manufacturer.
   C. Manufacturers:
      4. Substitutions: See Section 01 60 00 - Product Requirements.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that soil surfaces are unfrozen, sufficiently dry to absorb toxicant, and ready to receive treatment.
   B. Verify final grading is complete.

3.02 APPLICATION - CHEMICAL TREATMENT
   A. Comply with requirements of U.S. EPA and applicable state and local codes.
   B. Spray apply toxicant in accordance with manufacturer's instructions.
   C. Apply toxicant at following locations:
      1. Under Slabs-on-Grade.
      2. At Both Sides of Foundation Surface.
   D. Under slabs, apply toxicant immediately prior to installation of vapor barrier.
   E. At foundation walls, apply toxicant immediately prior to finish grading work outside foundations.
F. Apply extra treatment to structure penetration surfaces such as pipe or ducts, and soil penetrations such as grounding rods or posts.

G. Re-treat disturbed treated soil with same toxicant as original treatment.

H. If inspection or testing identifies the presence of termites, re-treat soil and re-test.

3.03 PROTECTION

A. Do not permit soil grading over treated work.

END OF SECTION
SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

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

1.02 SUMMARY
A. Section Includes Concrete Paving Including the Following:
   1. Walks.
   2. Stairs.
B. Related Requirements:
   1. Section 03 30 00 "Cast-in-Place Concrete" for general building applications of concrete.
   2. Section 32 13 73 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.
   3. Section 32 17 23 "Pavement Markings."

1.03 DEFINITIONS
A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
B. W/C Ratio: The ratio by weight of water to cementitious materials.

1.04 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at project site.
   1. Review methods and procedures related to concrete paving, including but not limited to, the following:
      a. Concrete mixture design.
      b. Quality control of concrete materials and concrete paving construction practices.
   2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Concrete paving Subcontractor.
      d. Civil Engineer.

1.05 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
C. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.06 INFORMATIONAL SUBMITTALS
A. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement.
   4. Admixtures.
5. Curing compounds.
7. Bonding agent or epoxy adhesive.
8. Joint fillers.

B. Material Test Reports: For each of the following:
   1. Aggregates

C. Field quality-control reports.

1.07 QUALITY ASSURANCE
A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94 requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA’s "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   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.

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 of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
   2. Build mockups of concrete paving in the location and of the size indicated or, if not indicated, build mockups where directed by Engineer and not less than 96 inches by 96 inches. Include full-size detectable warning.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.08 PRECONSTRUCTION TESTING
A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

1.09 FIELD CONDITIONS
A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
   1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
   2. Do not use frozen materials or materials containing ice or snow.
   3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

C. Hot-Weather Concrete Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
   1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature,
provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.

3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

**PART 2 PRODUCTS**

**2.01 CONCRETE, GENERAL**

A. ACI Publications: Comply with ACI 301 unless otherwise indicated.

**2.02 FORMS**

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less. Do not use notched and bent forms.

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

**2.03 STEEL REINFORCEMENT**

A. Plain-Steel Welded-Wire Reinforcement: ASTM A1064, fabricated from steel wire into flat sheets.


D. Reinforcing Bars: ASTM A615, Grade 60; deformed.

E. Galvanized Reinforcing Bars: ASTM A767, Class II zinc coated, hot-dip galvanized after fabrication and bending; with ASTM A615, Grade 60 deformed bars.

F. Epoxy-Coated Reinforcing Bars: ASTM A775 or ASTM A934; with ASTM A615, Grade 60 deformed bars.

G. Steel Bar Mats: ASTM A184; with ASTM A615, Grade 60 deformed bars; assembled with clips.

H. Plain-Steel Wire: ASTM A1064.

I. Deformed-Steel Wire: ASTM A1064.

J. Epoxy-Coated-Steel Wire: ASTM A88, Class A; coated, plain.

K. Joint Dowel Bars: ASTM A61, Grade 60 plain-steel bars zinc coated (galvanized) after fabrication according to ASTM A767, Class I coating. Cut bars true to length with ends square and free of burrs.

L. Epoxy-Coated, Joint Dowel Bars: ASTM A775; with ASTM A615, Grade 60 plain-steel bars.

M. Tie Bars: ASTM A615, Grade 60; deformed.

N. Hook Bolts: ASTM A307, Grade A, internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.

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

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.

P. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

Q. Zinc Repair Material: ASTM A780.

2.04 CONCRETE MATERIALS

A. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
   1. Portland Cement: ASTM C150, white portland cement Type I or Type II.
   2. Fly Ash: ASTM C618, Class C or Class F.
   3. Slag Cement: ASTM C989, Grade 100 or 120.

   2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Exposed Aggregate: Selected, hard, and durable; washed; free of materials with deleterious reactivity to cement or that cause staining; from a single source, with gap-graded coarse aggregate as follows:
   1. Aggregate Sizes: 3/4 to 1 inch nominal.


E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
   1. Water-Reducing Admixture: ASTM C494, Type A.
   2. Retarding Admixture: ASTM C494, Type B.
   3. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
   4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.
   5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494, Type G.
   6. Plasticizing and Retarding Admixture: ASTM C1017, Type II.

F. Water: Potable and complying with ASTM C94.

2.05 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116, Type III, 1/2 to 1-1/2 inches long.

B. Synthetic Fiber: Fibrillated polypropylene fibers engineered and designed for use in decorative concrete paving, complying with ASTM C1116, Type III, 1/2 to 1-1/2 inches long.

2.06 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.
F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 2, Class B, dissipation.

2.07 RELATED MATERIALS

A. Joint Fillers: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork in preformed strips.

B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

C. Bonding Agent: ASTM C1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy-Bonding Adhesive: ASTM C881, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:
   1. Types I and II, nonload bearing or Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

2.08 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
   1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
   2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.

B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
   1. Fly Ash or Pozzolan: 25 percent.
   2. Slag Cement: 50 percent.
   3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
   1. Air Content: 5 to 8 percent plus or minus 1-1/2 percent for 1-1/2-inch nominal maximum aggregate size.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.5 lb/cu. yd.

G. Concrete Mixtures: Normal-weight concrete.
   2. Maximum W/C Ratio at Point of Placement: 0.45.
3. Slump Limit: 2 to 5 inches.

2.09 CONCRETE MIXING
A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116. Furnish batch certificates for each batch discharged and used in the Work.
   1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.
B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94. Mix concrete materials in appropriate drum-type batch machine mixer.
   1. For concrete batches of 1 cu. yd. 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 concrete batches larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd.
   3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixing time, quantity, and amount of water added.

PART 3 EXECUTION
3.01 EXAMINATION
A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION
A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.03 EDGE FORMS AND SCREED CONSTRUCTION
A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.04 STEEL REINFORCEMENT INSTALLATION
A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

E. Zinc-Coated Reinforcement: Use galvanized-steel wire ties to fasten zinc-coated reinforcement. Repair cut and damaged zinc coatings with zinc repair material.

F. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963.

G. Install fabricated bar mats in lengths as long as practicable. Handle units to keep them flat and free of distortions. Straighten bends, kinks, and other irregularities, or replace units as required before placement. Set mats for a minimum 2-inch overlap of adjacent mats.

3.05 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes.
a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
   a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

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

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.06 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement dowels and joint devices.

H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.
   1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

3.07 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven
floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

3.08 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
B. Comply with ACI 306.1 for cold-weather protection.
C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. 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.
D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
E. Curing Methods: Cure concrete by a combination of these as follows:

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 lap over adjacent absorptive covers.
2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

3.09 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 as follows:

1. Elevation: 3/4 inch.
3. Surface: Gap below 10-feet-long; unleveled straightedge not to exceed 1/2 inch.
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.
3.10  FIELD QUALITY CONTROL

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

B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172 shall be performed according to the following requirements:
   1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
      a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
   2. Slump: ASTM C143; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
   3. Air Content: ASTM C231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
   4. Concrete Temperature: ASTM C1064; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.
   5. Compression Test Specimens: ASTM C31; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
   6. Compressive-Strength Tests: ASTM C39; test one specimen at seven days and two specimens at 28 days.
      a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Engineer, 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.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Engineer but will not be used as sole basis for approval or rejection of concrete.

F. 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 Engineer.

G. Concrete paving will be considered defective if it does not pass tests and inspections.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

I. Prepare test and inspection reports.

3.11  REPAIR AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Engineer.

B. Drill test cores, where directed by Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION
SECTION 32 13 73
CONCRETE PAVING JOINT SEALANTS

PART 1 GENERAL

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

1.02 SUMMARY
A. Section Includes:
   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.
   3. Cold-applied, fuel-resistant joint sealants.
   5. Joint-sealant backer materials.
   6. Primers.

1.03 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.

1.04 ACTION SUBMITTALS
A. Product Data: For each type of product.
B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
C. Paving-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.05 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Product Certificates: For each type of joint sealant and accessory.

1.06 QUALITY ASSURANCE
A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
B. Product Testing: Test joint sealants using a qualified testing agency.

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

2.01 MATERIALS, GENERAL
   A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.

2.02 COLD-APPLIED JOINT SEALANTS
   A. Multicomponent, Nonsag, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade NS, Class 25, for Use T.
   B. Single Component, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
   C. Multicomponent, Pourable, Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 25, for Use T.

2.03 HOT-APPLIED JOINT SEALANTS
   B. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I or Type II.
   C. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type I, II, or III.
   D. Hot-Applied, Single-Component Joint Sealant: ASTM D6690, Type IV.

2.04 COLD-APPLIED, FUEL-RESISTANT JOINT SEALANTS
   A. Fuel-Resistant, Single-Component, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type S, Grade P, Class 25, for Use T.
   B. Fuel-Resistant, Multicomponent, Pourable, Modified-Urethane, Elastomeric Joint Sealant: ASTM C920, Type M, Grade P, Class 12-1/2 or 25, for Use T.

2.05 HOT-APPLIED, FUEL-RESISTANT JOINT SEALANTS
   A. Hot-Applied, Fuel-Resistant, Single-Component Joint Sealants: ASTM D7116, Type I or Type II.

2.06 JOINT-SEALANT BACKER MATERIALS
   A. Joint-Sealant Backer Materials: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by joint-sealant manufacturer, based on field experience and laboratory testing.
   B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
   C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.
   D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.07 PRIMERS
   A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated.
PART 3 EXECUTION

3.01 EXAMINATION

A. Examine joints 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.

3.02 PREPARATION

A. Surface Cleaning of Joints: Before installing joint sealants, clean out joints immediately to comply with joint-sealant manufacturer's written instructions.
   1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.

B. Joint Priming: Prime joint substrates where indicated or 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.

3.03 INSTALLATION OF JOINT SEALANTS

A. Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions.

C. Install joint-sealant backings to support joint 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 joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants immediately following backing installation, using proven techniques that comply with the following:
   1. Place joint sealants so they fully contact joint substrates.
   2. Completely fill recesses in each joint configuration.
   3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements 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 joint sealant from surfaces adjacent to joints.
   2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.
3.04 CLEANING AND PROTECTION
   A. Clean off excess joint sealant as the Work progresses, by methods and with cleaning materials approved in writing by joint-sealant manufacturers.
   B. 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 and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

3.05 PAVING-JOINT-SEALANT SCHEDULE
   A. Joint-Sealant Application: Joints within concrete paving.
      1. Joint Location:
         a. Expansion and isolation joints in concrete paving.
         b. Contraction joints in concrete paving.
         c. Other joints as indicated.
   B. Joint-Sealant Application: Joints within concrete paving and between concrete and asphalt paving.
      1. Joint Location:
         a. Joints between concrete and asphalt paving.
         b. Joints between concrete curbs and asphalt paving.
         c. Other joints as indicated.
   C. Joint-Sealant Application: Fuel-resistant joints within concrete paving.
      1. Joint Location:
         a. Expansion and isolation joints in concrete paving.
         b. Contraction joints in concrete paving.
         c. Other joints as indicated.

END OF SECTION
SECTION 32 92 19
SEEDING

PART 1 GENERAL

1.01 SECTION INCLUDES
A. Seeding, mulching and fertilizer.

1.02 DEFINITIONS

1.03 SUBMITTALS
A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
B. Maintenance Data: Include maintenance instructions, cutting method and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

1.04 REGULATORY REQUIREMENTS
A. Comply with regulatory agencies for fertilizer and herbicide composition.
B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

1.05 DELIVERY, STORAGE, AND HANDLING
A. Deliver grass seed mixture in sealed containers. Seed in damaged packaging is not acceptable. Deliver seed mixture in containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.
B. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.

PART 2 PRODUCTS

2.01 SEED MIXTURE
A. Seed Mixture: Delaware Standard Permanent Grass Seeding for Dry Ground
   1. Hard Fescue Blend: 55%
   2. Perennial Rye: 6%
   3. Redtop: 3%
   4. Winter Rye: 36%

2.02 SOIL MATERIALS
A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; pH value of minimum 5.4 and maximum 7.0.

2.03 ACCESSORIES
A. Mulching Material: Hemlock species wood cellulose fiber, dust form, free of growth or germination inhibiting ingredients.
B. Erosion Fabric: Jute matting, open weave.

PART 3 EXECUTION

3.01 EXAMINATION
A. Verify that prepared soil base is ready to receive the work of this Section.
3.02 PREPARATION

3.03 SEEDING

A. Do not seed areas in excess of that which can be mulched on same day.

B. Do not sow immediately following rain, when ground is too dry, or during windy periods.

C. Immediately following seeding and compacting, apply mulch to a thickness of 1/8 inches. Maintain clear of shrubs and trees.

D. Apply water with a fine spray immediately after each area has been mulched. Saturate to 4 inches of soil.

E. Following germination, immediately re-seed areas without germinated seeds that are larger than 4 by 4 inches.

3.04 PROTECTION

A. Cover seeded slopes where grade is 4 inches per foot or greater with erosion fabric. Roll fabric onto slopes without stretching or pulling.

B. Lay fabric smoothly on surface, bury top end of each section in 6 inch deep excavated topsoil trench. Provide 12 inch overlap of adjacent rolls. Backfill trench and rake smooth, level with adjacent soil.

C. Secure outside edges and overlaps at 36 inch intervals with stakes.

D. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.

E. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.

END OF SECTION
SECTION 32 93 00
PLANTS

PART 1 GENERAL

1.01 SECTION INCLUDES
   A. Preparation of subsoil.
   B. Topsoil bedding.
   C. New trees, plants, and ground cover.

1.02 RELATED REQUIREMENTS
   A. Section 31 22 00 - Grading: Topsoil material.
   B. Section 31 23 23 - Fill: Topsoil material.

1.03 DEFINITIONS
   A. Weeds: Any plant life not specified or scheduled.
   B. Plants: Living trees, plants, and ground cover specified in this Section, and described in ANSI Z60.1.

1.04 REFERENCE STANDARDS

1.05 SUBMITTALS
   A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
   B. See Section 01 32 00 - Submittal Procedures, for submittal procedures.
   C. Certificate: Certify fertilizer and herbicide mixture approval by authority having jurisdiction.

1.06 QUALITY ASSURANCE
   A. Nursery Qualifications: Company specializing in growing and cultivating the plants with five years documented experience.
   B. Installer Qualifications: Company specializing in installing and planting the plants with five years experience.

1.07 DELIVERY, STORAGE, AND HANDLING
   A. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
   B. Protect and maintain plant life until planted.
   C. Deliver plant life materials immediately prior to placement. Keep plants moist.

1.08 FIELD CONDITIONS

1.09 WARRANTY
   A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
   B. Provide two year warranty.
   C. Warranty: Include coverage for two continuous growing seasons; replace dead or unhealthy plants.
   D. Replacements: Plants of same size and species as specified, planted in the next growing season, with a new warranty commencing on date of replacement.
PART 2 PRODUCTS
2.01 REGULATORY REQUIREMENTS
   A. Comply with regulatory agencies for fertilizer and herbicide composition.

2.02 PLANTS
   A. Plants: Species and size identified in plant schedule, grown in climatic conditions similar to those in locality of the work.

2.03 SOIL MATERIALS
   A. Topsoil: Fertile, agricultural soil, typical for locality, capable of sustaining vigorous plant growth, taken from drained site; free of subsoil, clay or impurities, plants, weeds and roots; minimum pH value of 5.4 and maximum 7.0.

2.04 SOIL AMENDMENT MATERIALS
   A. Fertilizer: Containing fifty percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil, as indicated in analysis.

2.05 MULCH MATERIALS
   A. Mulching Material: hardwood species wood shavings, free of growth or germination inhibiting ingredients.

2.06 ACCESSORIES
   A. Stakes: Softwood lumber, pointed end.

PART 3 EXECUTION
3.01 EXAMINATION
   A. Verify that prepared subsoil and planters are ready to receive work.
   B. Saturate soil with water to test drainage.
   C. Verify that required underground utilities are available, in proper location, and ready for use.

3.02 PREPARATION OF SUBSOIL
   A. Prepare subsoil to eliminate uneven areas. Maintain profiles and contours. Make changes in grade gradual. Blend slopes into level areas.
   B. Remove foreign materials, weeds and undesirable plants and their roots. Remove contaminated subsoil.
   C. Scarify subsoil to a depth of 3 inches where plants are to be placed. Repeat cultivation in areas where equipment, used for hauling and spreading topsoil, has compacted subsoil.
   D. Dig pits and beds 6 inches larger than plant root system.

3.03 PLACING TOPSOIL
   A. Spread topsoil to a minimum depth of 4 inches over area to be planted. Rake smooth.
   B. Place topsoil during dry weather and on dry unfrozen subgrade.
   C. Remove vegetable matter and foreign non-organic material from topsoil while spreading.
   D. Grade topsoil to eliminate rough, low or soft areas, and to ensure positive drainage.
   E. Install topsoil into pits and beds intended for plant root balls, to a minimum thickness of 6 inches.

3.04 FERTILIZING
   A. Apply fertilizer in accordance with manufacturer’s instructions.
   B. Apply after initial raking of topsoil.
C. Mix thoroughly into upper 2 inches of topsoil.
D. Lightly water to aid the dissipation of fertilizer.

3.05 PLANTING
A. Place plants for best appearance.
B. Set plants vertical.
C. Remove non-biodegradable root containers.
D. Set plants in pits or beds, partly filled with prepared plant mix, at a minimum depth of 6 inches under each plant. Remove burlap, ropes, and wires, from the root ball.
F. Saturate soil with water when the pit or bed is half full of topsoil and again when full.

3.06 INSTALLATION OF ACCESSORIES
A. Place mulch at a minimum depth of 3 inches at all planting locations.

END OF SECTION