SECTION 081213 - HOLLOW METAL FRAMES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes hollow-metal frames.
   B. Related Requirements:
      1. Section 081416 "Flush Wood Doors" for wood doors installed in hollow-metal frames.
      2. Section 099600 "High Performance Coatings" for finish coating compatibility with primers listed in this section.

1.3 DEFINITIONS
   A. Minimum Thickness: Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.4 COORDINATION
   A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

1.5 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.6 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Include construction details, material descriptions, fire-resistance ratings, and finishes.
   B. Shop Drawings: Include the following:
      1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
      2. Locations of reinforcement and preparations for hardware.
      3. Details of each different wall opening condition.
      4. Details of anchorages, joints, field splices, and connections.
      5. Details of moldings, removable stops, and glazing.
      6. Details of conduit and preparations for power, signal, and control systems.
C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Samples for Verification: Prepare Samples to demonstrate compliance with requirements for quality of materials and construction. Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.

E. Schedule: Provide a schedule of hollow-metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final Door Hardware Schedule.

1.7 INFORMATIONAL SUBMITTALS

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

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver hollow-metal work palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

   1. Provide additional protection to prevent damage to factory-finished units.

B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow-metal work vertically under cover at Project site with head up. Place on minimum 4-inch (102-mm-) high wood blocking. Provide minimum 1/4-inch (6-mm) space between each unit to permit air circulation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. Amweld International, LLC.
   2. Ceco Door Products; an Assa Abloy Group company.
   3. Curries Company; an Assa Abloy Group company.
   4. Steelcraft; an Ingersoll-Rand company.
   5. Steward Steel; Door Division.

B. Source Limitations: Obtain hollow-metal work from single source from single manufacturer.

2.2 REGULATORY REQUIREMENTS
A. Fire-Rated Assemblies: Complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

B. Fire-Rated, Borrowed-Light Assemblies: Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

2.3 INTERIOR FRAMES

A. Construct interior frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.

B. Heavy-Duty Frames: SDI A250.8, Level 2.

1. Physical Performance: Level B according to SDI A250.4.
2. Materials: 16 gage, uncoated steel sheet, minimum thickness of 0.053 inch (1.3 mm).

2.4 EXTERIOR HOLLOW-METAL FRAMES

A. Construct exterior frames to comply with the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.


1. Physical Performance: Level A according to SDI A250.4Frames:
2. Materials: 14 gage, metallic-coated steel sheet, minimum thickness of 0.064 inch (1.628 mm), with minimum A60 galvannealed coating.
4. Exposed Finish: Prime

2.5 FRAME ANCHORS

A. Jamb Anchors:

1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch (1.0 mm) thick, with corrugated or perforated straps not less than 2 inches (51 mm) wide by 10 inches (254 mm) long; or wire anchors not less than 0.177 inch (4.5 mm) thick.
2. Stud-Wall Type: Designed to engage stud, standard snap-in type; not less than 0.042 inch (1.0 mm) thick.
3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch- (9.5-mm-) diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
B. **Floor Anchors:** Formed from same material as frames, minimum thickness of 0.042 inch (1.0 mm), and as follows:

   1. **Monolithic Concrete Slabs:** Welded floor anchors, with two holes to receive fasteners.
   2. **Separate Topping Concrete Slabs:** Adjustable-type anchors with extension clips, allowing not less than 2-inch (51-mm) height adjustment. Terminate bottom of frames at finish floor surface.

### 2.6 MATERIALS

A. **Cold-Rolled Steel Sheet:** ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. **Hot-Rolled Steel Sheet:** ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.

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

D. **Frame Anchors:** ASTM A 879/A 879M, Commercial Steel (CS), 04Z (12G) coating designation; mill phosphatized.

   1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.

E. **Inserts, Bolts, and Fasteners:** Hot-dip galvanized according to ASTM A 153/A 153M.

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

G. **Grout:** ASTM C 476, except with a maximum slump of 4 inches (102 mm), as measured according to ASTM C 143/C 143M.

H. **Mineral-Fiber Insulation:** ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool with 6- to 12-lb/cu. ft. (96- to 192-kg/cu. m) density; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. **Glazing:** Comply with requirements in Section 088000 "Glazing."

J. **Bituminous Coating:** Cold-applied asphalt mastic, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

### 2.7 FABRICATION

A. Fabricate hollow-metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
B. Hollow-Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.

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

3. Grout Guards: Weld guards to frame at back of hardware mortises in frames to be grouted.

4. Floor Anchors: Weld anchors to bottoms of jambs with at least four spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.

5. Jamb Anchors: Provide number and spacing of anchors as follows:

   a. Masonry Type: Locate anchors not more than 16 inches (406 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c., to match coursing, and as follows:

      1) Two anchors per jamb up to 60 inches (1524 mm) high.
      2) Three anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Four anchors per jamb from 90 to 120 inches (2286 to 3048 mm) high.
      4) Four anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 120 inches (3048 mm) high.

   b. Stud-Wall Type: Locate anchors not more than 18 inches (457 mm) from top and bottom of frame. Space anchors not more than 32 inches (813 mm) o.c. and as follows:

      1) Three anchors per jamb up to 60 inches (1524 mm) high.
      2) Four anchors per jamb from 60 to 90 inches (1524 to 2286 mm) high.
      3) Five anchors per jamb from 90 to 96 inches (2286 to 2438 mm) high.
      4) Five anchors per jamb plus one additional anchor per jamb for each 24 inches (610 mm) or fraction thereof above 96 inches (2438 mm) high.

   c. Compression Type: Not less than two anchors in each frame.

   d. Postinstalled Expansion Type: Locate anchors not more than 6 inches (152 mm) from top and bottom of frame. Space anchors not more than 26 inches (660 mm) o.c.

6. Head Anchors: Two anchors per head for frames more than 42 inches (1067 mm) wide and mounted in metal-stud partitions.

7. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.

   a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
   b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.

C. Hardware Preparation: Factory prepare hollow-metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to SDI A250.6, the Door Hardware Schedule, and templates.

1. Reinforce frames to receive nontemplated, mortised, and surface-mounted hardware.
2. Comply with applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow-metal work for hardware.

D. Stops and Moldings: Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
   1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow-metal work.
   2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
   3. Provide fixed frame moldings on outside of exterior and on secure side of interior frames.
   4. Provide loose stops and moldings on inside of hollow-metal work.
   5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.8 STEEL FINISHES

A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
   1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
      a. Verify primer compatibility with Division 9 “High Performance Coatings.”

2.9 ACCESSORIES

A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.

B. Grout Guards: Formed from same material as frames, not less than 0.016 inch (0.4 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

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

3.2 PREPARATION

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

3.3 INSTALLATION

A. General: Install hollow-metal work plumb, rigid, properly aligned, and securely fastened in place. Comply with Drawings and manufacturer's written instructions.

B. Hollow-Metal Frames: Install hollow-metal frames of size and profile indicated. Comply with SDI A250.11 or NAAMM-H学生HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
   a. At fire-rated openings, install frames according to NFPA 80.
   b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
   c. Install frames with removable stops located on secure side of opening.
   d. Install door silencers in frames before grouting.
   e. Remove temporary braces necessary for installation only after frames have been properly set and secured.
   f. Check plumb, square, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
   g. Field apply bituminous coating to backs of frames that will be filled with grout containing antifreezing agents.

2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
   a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.


4. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Concrete Walls: Solidly fill space between frames and concrete with mineral-fiber insulation.

6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.

7. In-Place Metal or Wood-Stud Partitions: Secure slip-on drywall frames in place according to manufacturer's written instructions.

8. Installation Tolerances: Adjust hollow-metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
   a. Squareness: Plus or minus 1/16 inch (1.6 mm), measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
   b. Alignment: Plus or minus 1/16 inch (1.6 mm), measured at jambs on a horizontal line parallel to plane of wall.
   c. Twist: Plus or minus 1/16 inch (1.6 mm), measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
   d. Plumbness: Plus or minus 1/16 inch (1.6 mm), measured at jambs at floor.
C. Glazing: Comply with installation requirements in Section 088000 "Glazing" and with hollow-metal manufacturer's written instructions.

1. Secure stops with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches (230 mm) o.c. and not more than 2 inches (51 mm) o.c. from each corner.

3.4 ADJUSTING AND CLEANING

A. Final Adjustments: Remove and replace defective work, including hollow-metal work that is warped, bowed, or otherwise unacceptable.

B. Remove grout and other bonding material from hollow-metal work immediately after installation.

C. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.

D. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

E. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.

F. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION 081213
SECTION 081416 - FLUSH WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Solid-core doors with wood-veneer faces.
2. Factory finishing flush wood doors.
3. Factory fitting flush wood doors to frames and factory machining for hardware.

B. Related Sections:

1. Division 08 Section "Glazing" for glass view panels in flush wood doors.
2. Division 09 Sections "Interior Painting" for field finishing doors.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, and trim for openings. Include factory-finishing specifications.

B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each kind of door; construction details not covered in Product Data; location and extent of hardware blocking; and other pertinent data.

1. Indicate dimensions and locations of mortises and holes for hardware.
2. Indicate dimensions and locations of cutouts.
3. Indicate requirements for veneer matching.
4. Indicate doors to be factory finished and finish requirements.
5. Indicate fire-protection ratings for fire-rated doors.

C. Samples for Initial Selection: For factory-finished doors.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain flush wood doors from single manufacturer.

B. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, "Architectural Wood Flush Doors."

C. Fire-Rated Wood Doors: Doors complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection ratings indicated, based on testing at as close to neutral pressure as possible according to.
1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

2. Temperature-Rise Limit: At vertical exit enclosures and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire-test exposure.

D. Preinstallation Conference: Conduct conference at Project site.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package doors individually in plastic bags or cardboard cartons and wrap bundles of doors in plastic sheeting.

C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F (16 and 32 deg C) and relative humidity between 43 and 70 percent during the remainder of the construction period.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Warping (bow, cup, or twist) more than 1/4 inch (6.4 mm) in a 42-by-84-inch (1067-by-2134-mm) section.
   b. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch (0.25 mm in a 76.2-mm) span.

2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.


PART 2 - PRODUCTS
2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Algoma Hardwoods, Inc.
   2. Eggers Industries.
   3. Graham; an Assa Abloy Group company.
   5. VT Industries Inc.

2.2 DOOR CONSTRUCTION, GENERAL

A. WDMA I.S.1-A Performance Grade:
   1. Heavy Duty unless otherwise indicated.
   2. Extra Heavy Duty: Janitor’s closets and storage closets.

B. Particleboard-Core Doors:
   1. Particleboard: ANSI A208.1, Grade LD-1 or Grade LD-2.
   2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

C. Structural-Composite-Lumber-Core Doors:
      a. Screw Withdrawal, Face: 700 lbf (3100 N).
      b. Screw Withdrawal, Edge: 400 lbf (1780 N).

D. Fire-Protection-Rated Doors: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
   1. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
      a. Finish steel edges and astragals to match door hardware (locksets or exit devices).

2.3 VENEERED-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:
   1. Grade: Custom (Grade A faces)
   2. Species: White Birch (NO HEARTWOOD)
   4. Assembly of Veneer Leaves on Door Faces: Running match.
   5. Pair and Set Match: Provide for doors hung in same opening or separated only by mullions.
   6. Room Match: Match door faces within each separate room or area of building. Corridor-door faces do not need to match where they are separated by 20 feet (6 m) or more.
7. Room Match: Provide door faces of compatible color and grain within each separate room or area of building.
8. Exposed Vertical Edges: Same species as faces.
10. Construction: Seven plies, either bonded or nonbonded construction.
11. WDMA I.S.1-A Performance Grade:
   1. Particleboard: ANSI A208.1, Grade LD-1 or Grade LD-2.
   2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.

2.4 LOUVERS AND LIGHT FRAMES

A. Metal Louvers:
   1. Blade Type: Vision-proof, inverted V.
   2. Metal and Finish: Hot-dip galvanized steel, 0.040 inch (1.0 mm) thick, factory primed for paint finish.

B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch- (1.2-mm-) thick, cold-rolled steel sheet; factory primed for paint finish; and approved for use in doors of fire-protection rating indicated.

2.5 FABRICATION

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

B. Factory machine doors for hardware that is not surface applied. Locate hardware to comply with DHI-WDHS-3. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
   1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
   2. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.

C. Openings: Cut and trim openings through doors in factory.
   1. Light Openings: Trim openings with moldings of material and profile indicated.
   2. Louvers: Factory install louvers in prepared openings.

2.6 FACTORY FINISHING

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

C. Transparent Finish:
   1. Grade: Custom.
   2. Finish: Manufacturer’s standard complying with WDMA.
   3. Staining: Custom color to match sample provided by Architect.
   4. Effect: Semifilled finish, produced by applying an additional finish coat to partially fill the wood pores.
   5. Sheen: Semigloss.

PART 3 - EXECUTION

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

3.2 INSTALLATION
   A. Installation Instructions: Install doors to comply with manufacturer’s written instructions and the referenced quality standard, and as indicated.
      1. Install fire-rated doors in corresponding fire-rated frames according to NFPA 80.
   B. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.
   C. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

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

END OF SECTION 081416
SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

B. Related Sections:
   1. Division 08 Section “Glazed Aluminum Curtain Walls” for curtain-wall systems that mechanically retain glazing on four sides.
   2. Division 08 Section “Glazing” for glass and insulated glass units installed in aluminum-framed systems and doors.

1.3 DEFINITIONS

A. ADA/ABA Accessibility Guidelines: U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disability Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities."

1.4 PERFORMANCE REQUIREMENTS

A. General Performance: Aluminum-framed systems shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction:

   1. Movements of supporting structure indicated on Drawings including, but not limited to, story drift and deflection from uniformly distributed and concentrated live loads.
   2. Dimensional tolerances of building frame and other adjacent construction.
   3. Failure includes the following:
      a. Deflection exceeding specified limits.
      b. Thermal stresses transferring to building structure.
      c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
      d. Glazing-to-glazing contact.
      e. Noise or vibration created by wind and by thermal and structural movements.
      f. Loosening or weakening of fasteners, attachments, and other components.
      g. Sealant failure.
      h. Failure of operating units.
B. Structural Loads:

1. Wind Loads:
   a. Basic Wind Speed: 90 mph (40 m/s) Verify with International Building Code.
   b. Importance Factor: 1.15.
   c. Exposure Category: C.

C. Deflection of Framing Members:

1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane shall not exceed L/175 of the glass edge length for each individual glazing lite or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.
2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

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

1. When tested at positive and negative wind-load design pressures, systems do not evidence deflection exceeding specified limits.

E. Air Infiltration: Provide aluminum-framed systems with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. (0.03 L/s per sq. m) of fixed wall area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft. (75 Pa).

F. Water Penetration under Static Pressure: Provide aluminum-framed systems that do not evidence water penetration through fixed glazing and framing areas when tested according to ASTM E 331 at a minimum static-air-pressure difference of 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (300 Pa).

G. Water Penetration under Dynamic Pressure: Provide aluminum-framed systems that do not evidence water leakage through fixed glazing and framing areas when tested according to AAMA 501.1 under dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 10 lbf/sq. ft. (300 Pa).

1. Maximum Water Leakage: No uncontrolled water penetrating aluminum-framed systems or water appearing on systems' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior and water that cannot damage adjacent materials or finishes.

H. Thermal Movements: Provide aluminum-framed systems that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
2. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
   a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F (82 deg C).
b. Low Exterior Ambient-Air Temperature: 0 deg F (minus 18 deg C).

3. Interior Ambient-Air Temperature: 75 deg F (24 deg C).

I. Condensation Resistance: Provide aluminum-framed systems with fixed glazing and framing areas having condensation-resistance factor (CRF) of not less than 55 when tested according to AAMA 1503.

J. Thermal Conductance: Provide aluminum-framed systems with fixed glazing and framing areas having an average U-factor of not more than 0.57 Btu/sq. ft. x h x deg F (3.23 W/sq. m x K) when tested according to AAMA 1503.

K. Sound Transmission: Provide aluminum-framed systems with fixed glazing and framing areas having the following sound-transmission characteristics:

1. Sound Transmission Class (STC): Minimum 26 STC when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 413.

L. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by aluminum-framed systems without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.

1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.

M. Structural-Sealant Joints: Designed to produce tensile or shear stress of less than 20 psi (138 kPa).

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for aluminum-framed systems.

B. Shop Drawings: For aluminum-framed systems. Include plans, elevations, sections, details, and attachments to other work.

1. Include details of provisions for system expansion and contraction and for drainage of moisture in the system to the exterior.

C. Samples for Initial Selection: For units with factory-applied color finishes.

D. Other Action Submittals:

1. Entrance Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.
1.6 INFORMATIONAL SUBMITTALS


B. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Testing Agency Qualifications: Qualified according to ASTM E 699 for testing indicated.

C. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project.

D. Product Options: Information on Drawings and in Specifications establishes requirements for systems' aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.

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

E. Source Limitations for Aluminum-Framed Systems: Obtain from single source from single manufacturer.


G. Structural-Sealant Joints: Design reviewed and approved by structural-sealant manufacturer.

H. Welding Qualifications: Qualify procedures and personnel according to AWS D1.2, "Structural Welding Code - Aluminum."

I. Preinstallation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of aluminum-framed systems that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration caused by thermal movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Adhesive or cohesive sealant failures.
   e. Water leakage through fixed glazing and framing areas.
   f. Failure of operating components.

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

B. Special Finish Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components on which finishes do not comply with requirements or that fail in materials or workmanship within specified warranty period. Warranty does not include normal weathering.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 MAINTENANCE SERVICE

A. Entrance Door Hardware:

   1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. EXTERIOR STOREFRONT FRAMING

   1. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; an Alcoa company. Trifab VG 451T with 2” x 4 ½” sightlines.

   2. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer North America; an Alcoa company. EnCORE Framing System with 1-3/4” x 6” sightlines.

2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

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

B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer, complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
1. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
2. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
3. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.3 FRAMING SYSTEMS

A. Framing Members: Manufacturer's standard extruded-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   2. Glazing System: Retained mechanically with gaskets on four sides
   3. Glazing Plane: As indicated

B. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

C. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
   1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
   2. Reinforce members as required to receive fastener threads.
   3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

D. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts, complying with ASTM A 123/A 123M or ASTM A 153/A 153M.

E. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.

F. Framing System Gaskets and Sealants: Manufacturer's standard, recommended by manufacturer for joint type.

2.4 GLAZING SYSTEMS

A. Glazing: As specified in Division 08 Section "Glazing."

B. Glazing Gaskets: Manufacturer's standard compression types; replaceable, molded or extruded, of profile and hardness required to maintain watertight seal.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

E. Glazing Sealants: For structural-sealant-glazed systems, as recommended by manufacturer for joint type, and as follows:
   1. Structural Sealant: ASTM C 1184, single-component neutral-curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by a structural-sealant manufacturer for use in aluminum-framed systems indicated.
a. Color: As selected by Architect from manufacturer's full range of colors.

2. Weatherseal Sealant: ASTM C 920 for Type S, Grade NS, Class 25, Uses NT, G, A, and O; single-component neutral-curing formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and aluminum-framed-system manufacturers for this use.

2.5 ENTRANCE DOOR SYSTEMS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer entrance doors.

B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
   1. Door Construction: 1-3/4-inch (44.5-mm) overall thickness, with minimum 0.125-inch- (3.2-mm-) thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
   2. Door Design: Medium stile; 3-1/2-inch (88.9-mm) nominal width.
      a. Provide nonremovable glazing stops on outside of door.

2.6 ENTRANCE DOOR HARDWARE

A. General: Provide entrance door hardware for each entrance door to comply with requirements in this Section.
   1. Sequence of Operation: Provide electrified door hardware function, sequence of operation, and interface with other building control systems indicated.
   2. Opening-Force Requirements:
      a. Egress Doors: Not more than 15 lbf (67 N) to release the latch, not more than 30 lbf (133 N) to set the door in motion and not more than 15 lbf (67 N) to open the door to its minimum required width.

B. Opening-Force Requirements:
   1. Delayed-Egress Locks: Lock releases within 15 seconds after applying a force of not more than 15 lbf (67 N) for not more than 3 seconds.
   2. Latches and Exit Devices: Not more than 15 lbf (67 N) required to release latch.

C. Continuous-Gear Hinges: Manufacturer's standard with stainless-steel bearings between knuckles, fabricated to full height of door and frame.

D. Mortise Auxiliary Locks: BHMA A156.5, Grade 1.

E. Manual Flush Bolts: BHMA A156.16, Grade 1.

F. Automatic and Self-Latching Flush Bolts: BHMA A156.3, Grade 1.
G. Panic Exit Devices: BHMA A156.3, Grade 1, listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.

H. Strikes: Provide strike with black-plastic dust box for each latch or lock bolt; fabricated for aluminum framing.

I. Operating Trim: BHMA A156.6.

J. Concealed Overhead Holders: BHMA A156.8, Grade 1.

K. Surface-Mounted Holders: BHMA A156.16, Grade 1.

L. Weather Stripping: Manufacturer's standard replaceable components.
   1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC.
   2. Sliding Type: AAMA 701, made of wool, polypropylene, or nylon woven pile with nylon-fabric or aluminum-strip backing.

M. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.

N. Silencers: BHMA A156.16, Grade 1.

O. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch (13 mm).

2.7 ACCESSORY MATERIALS

A. Joint Sealants: For installation at perimeter of aluminum-framed systems, as specified in Division 07 Section "Joint Sealants."

B. Bituminous Paint: Cold-applied, asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos; formulated for 30-mil (0.762-mm) thickness per coat.

2.8 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Framing Members, General: Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints with ends coped or mitered.
   3. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
   4. Physical and thermal isolation of glazing from framing members.
5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
6. Provisions for field replacement of glazing from interior for vision glass and exterior for spandrel glazing or metal panels.
7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.

D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.

E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.

F. Storefront Framing: Fabricate components for assembly using shear-block system.

G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.

1. At exterior doors, provide compression weather stripping at fixed stops.
2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.

H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.

1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
2. At exterior doors, provide weather sweeps applied to door bottoms.

I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

J. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A32/A34, Class II, 0.010 mm or thicker.

1. Color: Dark bronze

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION
A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration.
6. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or applying sealant or tape, or by installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.

D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

E. Install components plumb and true in alignment with established lines and grades, and without warp or rack.

F. Install glazing as specified in Division 08 Section "Glazing."

1. Structural-Sealant Glazing:
   a. Prepare surfaces that will contact structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
   b. Install weatherseal sealant according to Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

G. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

H. Install perimeter joint sealants as specified in Division 07 Section "Joint Sealants" to produce weathertight installation.

3.3 ERECTION TOLERANCES

A. Install aluminum-framed systems to comply with the following maximum erection tolerances:

1. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet (3 mm in 3.7 m); 1/4 inch (6 mm) over total length.
2. Alignment:
   a. Where surfaces abut in line, limit offset from true alignment to 1/16 inch (1.5 mm).
   b. Where surfaces meet at corners, limit offset from true alignment to 1/32 inch (0.8 mm).

B. Diagonal Measurements: Limit difference between diagonal measurements to 1/8 inch (3 mm).

3.4 ADJUSTING

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

END OF SECTION 084113
SECTION 084413 - GLAZED ALUMINUM CURTAIN WALLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes conventionally glazed aluminum curtain walls installed as assemblies.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.

1.3 PERFORMANCE REQUIREMENTS

A. General Performance:  Comply with performance requirements specified, as determined by testing of manufacturer's standard glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.

1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.

2. Failure also includes the following:
   a. Thermal stresses transferring to building structure.
   b. Glass breakage.
   c. Noise or vibration created by wind and thermal and structural movements.
   d. Loosening or weakening of fasteners, attachments, and other components.
   e. Failure of operating units.

B. Structural Loads:

1. Wind Loads:

   b. Importance Factor: 1.15
   c. Exposure Category: C.

C. Structural-Test Performance: Test according to ASTM E 330 and TAS 202 as follows:

1. When tested at positive and negative wind load design pressures, assemblies do not evidence deflection exceeding L/175 of clear span.

2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2 percent of span.
3. Test Durations: As required by design wind velocity, but not less than 10 seconds.

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

1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches (4.1 m) and to 1/240 of clear span plus 1/4 inch (6.35 mm) for spans greater than 13 feet 6 inches (4.1 m) or an amount that restricts edge deflection of individual glazing lites to 3/4 inch (19 mm), whichever is less.

2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch (3.2 mm), whichever is smaller.

3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.

E. Water Penetration under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (480 Pa).

1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies’ normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters that is drained to exterior.

F. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:

1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).

3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.

G. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F (3.92 W/sq. m x K) as determined according to NFRC 100.

2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.35 as determined according to NFRC 200.

3. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.30 cfm/sq. ft. (1.50 L/s per sq. m) of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).

H. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:

1. Outdoor-Indoor Transmission Class: Minimum 26 when tested for laboratory sound transmission loss according to ASTM E 90 and determined by ASTM E 1332.

1.4 ACTION SUBMITTALS
A. **Product Data:** For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. **Shop Drawings:** For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
   1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
   2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
      a. Joinery, including concealed welds.
      b. Anchorage.
      c. Expansion provisions.
      d. Glazing.
      e. Flashing and drainage.
   3. Include laboratory mockup Shop Drawings, prepared by a qualified preconstruction testing agency, showing details of laboratory mockup.
      a. Resubmit Shop Drawings with changes made to glazed aluminum curtain walls to successfully complete preconstruction testing.

C. **Samples for Initial Selection:** For units with factory-applied color finishes.

1.5 **QUALITY ASSURANCE**

A. **Installer Qualifications:** Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. **Product Options:** Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
   1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.

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

D. **Energy Performance Standards:** Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
   1. Provide NFRC-certified glazed aluminum curtain walls with an attached label.

E. **Preinstallation Conference:** Conduct conference at Project site.

1.6 **PROJECT CONDITIONS**
A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 WARRANTY

A. Special Assembly Warranty: Standard form in which manufacturer or Installer agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including, but not limited to, excessive deflection.
   b. Noise or vibration created by wind and thermal and structural movements.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   d. Water penetration through fixed glazing and framing areas.
   e. Failure of operating components.

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

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
   a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
   b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
   c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings. Kawneer Clearwall Curtain Wall System

1. Clearwall™ (SSI): 2-1/2” x 7-1/2” (63.5 x 190.5), outside glazed with metal interfaced insulating glass (interface shop applied with structural silicone).

2.2 MATERIALS

A. Aluminum Extrusions: Alloy and temper recommended by glazed aluminum curtain wall manufacturer for strength, corrosion resistance, and application of required finish and not less than 0.070" (1.8) wall thickness at any location for the main frame and complying with ASTM B 221: 6063-T6 alloy and temper.

B. Aluminum sheet alloy: Shall meet the requirements of ASTM B209.

C. Fasteners: Aluminum, nonmagnetic stainless steel or other materials to be non-corrosive and compatible with aluminum window members, trim hardware, anchors, and other components.
D. Anchors, Clips, and Accessories: Aluminum, nonmagnetic stainless steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

E. Reinforcing Members: Aluminum, nonmagnetic stainless steel, or nickel/chrome-plated steel complying with ASTM B 456 for Type SC 3 severe service conditions, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 severe service conditions or other suitable zinc coating; provide sufficient strength to withstand design pressure indicated.

F. Sealant: For sealants required within fabricated curtain wall system, provide permanently elastic, non-shrinking, and non-migrating type recommended by sealant manufacturer for joint size and movement.

G. Tolerances: Reference to tolerances for wall thickness and other cross-sectional dimensions of glazed curtain wall members are nominal and in compliance with AA Aluminum Standards and Data.

2.3 FRAMING

A. Framing Members: Manufacturer’s standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
   1. Glazing System: Retained mechanically with toggles on four sides.

B. Glass:
   1. Clearwall™ (SS)/(SB): Outside glazed with 1-1/8" (28.6) insulating glass with 5/8" (15.9) recessed glass edge spacer supplied by qualified glass supplier.
   2. Clearwall™ (SSI)/(SBI): Outside glazed with metal interfaced 1" (25.4) insulating glass (interface shop applied with structural silicone).
   3. Clearwall™ (SSIT)/(SBIT): Outside glazed with metal interfaced 1" (25.4) insulating glass (interface shop applied with 3M™ VHB™ structural glazing tape).

C. Brackets and Reinforcements: Manufacturer’s standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

D. Framing Sealants: Shall be suitable for glazed aluminum curtain wall as recommended by sealant manufacturer.

E. Fasteners and Accessories: Manufacturer’s standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Where exposed shall be stainless steel.
   1. Toggle Assembly: Toggle assembly as tested by manufacturer.

F. Perimeter Anchors: When steel anchors are used, provide insulation between steel material and aluminum material to prevent galvanic action.

G. Packing, Shipping, Handling and Unloading: Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.

H. Storage and Protection: Store materials protected from exposure to harmful weather conditions. Handle curtain wall material and components to avoid damage. Protect curtain wall material against damage from elements, construction activities, and other hazards before, during and after installation.

2.4 GLAZING
A. Glazing: Comply with Division 08 Section “Glazing”. Following glazing options are available.

1. System: Outside toggle glazed format with 1" (25.4) or 1-1/8" (28.6) double glazed insulating glass.
   a. Clearwall™ (SS)/(SB): Outside glazed with 1-1/8" (28.6) insulating glass with 5/8" (15.9) recessed glass edge spacer supplied by qualified glass supplier.
   b. Clearwall™ (SSI)/(SBI): Outside glazed with metal interfaced 1" (25.4) insulating glass (interface shop applied with structural silicone).
   c. Clearwall™ (SSIT)/(SBIT): Outside glazed with metal interfaced 1" (25.4) insulating glass (interface shop applied with 3M™ VHB™ structural glazing tape). 3M™ to conduct application review prior to start of each project.

B. Glazing Gaskets: Gaskets to meet the requirements of ASTM C864.

C. Spacers and Setting Blocks: Manufacturer's standard elastomeric type.

D. Bond-Breaker Tape: Manufacturer's standard TFE-fluorocarbon or polyethylene material to which sealants will not develop adhesion.

2.5 ACCESSORY MATERIALS

A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.

2.6 FABRICATION

A. Form or extrude aluminum shapes before finishing.

B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.

C. Fabricate components that, when assembled, have the following characteristics:
   1. Profiles that are sharp, straight, and free of defects or deformations.
   2. Accurately fitted joints.
   3. Physical and thermal isolation of glazing from framing members.
   4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
   5. Provisions for field replacement of glazing from exterior.
   6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
   7. Internal weeping system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
   8. Double seal design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

D. Fabricate components that, when assembled, have the following characteristics:
   1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
   2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
E. Curtain-Wall Framing: Fabricate components for assembly using shear-block system following manufacturer’s standard installation instructions.

F. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.7 ALUMINUM FINISHES


PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

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

3.2 INSTALLATION

A. General:

1. Comply with manufacturer’s written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
7. Seal joints watertight unless otherwise indicated.

B. Metal Protection:

1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.

D. Install components plumb and true in alignment with established lines and grades.

E. Install glazing as specified in Division 08 Section "Glazing."

3.3 ERECTION TOLERANCES
A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:

1. Plumb: 1/8 inch in 10 feet (3.2 mm in 3 m); 1/4 inch in 40 feet (6 mm in 12 m).
2. Level: 1/8 inch in 20 feet (3.2 mm in 6 m); 1/4 inch in 40 feet (6 mm in 12 m).
3. Alignment:
   a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch (12.7 mm) wide, limit offset from true alignment to 1/16 inch (1.6 mm).
   b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch (12.7 to 25.4 mm) wide, limit offset from true alignment to 1/8 inch (3.2 mm).
   c. Where surfaces are separated by reveal or protruding element of 1 inch (25.4 mm) wide or more, limit offset from true alignment to 1/4 inch (6 mm).
4. Location: Limit variation from plane to 1/8 inch in 12 feet (3.2 mm in 3.7 m); 1/2 inch (12.7 mm) over total length.

END OF SECTION 084413
SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.
3. Storefront framing.

B. Related Sections:
   1. Division 08 Section "Mirrors."

1.3 DEFINITIONS

A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

C. Interspace: Space between lites of an insulating-glass unit.

1.4 PERFORMANCE REQUIREMENTS

A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.

   1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

C. Glass Type Factors for Wired, Patterned, and Sandblasted Glass:

   a. Short-Duration Glass Type Factor for Wired Glass: 0.5.
   b. Long-Duration Glass Type Factor for Wired Glass: 0.3.
   c. Short-Duration Glass Type Factor for Patterned Glass: 1.0.
d. Long-Duration Glass Type Factor for Patterned Glass: 0.6.
e. Short-Duration Glass Type Factor for Sandblasted Glass: 0.5.

1.5 ACTION SUBMITTALS

A. Product Data: For each glass product and glazing material indicated.

B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For glass and glazing products, from manufacturer.

B. Samples: For the following products, in the form of 12-inch-(300-mm-) square Samples for glass and of 12-inch-(300-mm-) long Samples for sealants. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
   1. Each color of tinted float glass.
   2. Ceramic-coated spandrel glass.
   3. Insulating glass for each designation indicated.
   4. For each color (except black) of exposed glazing sealant indicated.

C. Qualification Data: For installers.

D. Preconstruction Adhesion and Compatibility Test Report: From glazing sealant manufacturer indicating glazing sealants were tested for adhesion to glass and glazing channel substrates and for compatibility with glass and other glazing materials.

E. Warranties: Special warranties specified in this Section.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.

A. Installer Qualifications: An experienced installer who has completed glazing similar in material, design, and extent to that indicated for this Project; whose work has resulted in glass installations with a record of successful in-service performance; and who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

C. Elastomeric Glazing Sealant Product Testing: Obtain sealant test results for product test reports in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
1. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.

2. Test elastomeric glazing sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.

D. Preconstruction Adhesion and Compatibility Testing: Submit to elastomeric glazing sealant manufacturers, for testing indicated below, samples of each glazing material type, tape sealant, gasket, glazing accessory, and glass-framing member that will contact or affect elastomeric glazing sealants:

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.

2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.

3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

5. Testing will not be required if elastomeric glazing sealant manufacturers submit data based on previous testing of current sealant products for adhesion to, and compatibility with, glazing materials matching those submitted.

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


F. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

G. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.

H. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

I. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Review temporary protection requirements for glazing during and after installation.
1.8  DELIVERY, STORAGE, AND HANDLING

A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.9  PROJECT CONDITIONS

A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.10  WARRANTY

A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.

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

B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

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

C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

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

PART 2 - PRODUCTS

2.1  GLASS PRODUCTS, GENERAL
A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.

1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.

B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.

C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:

1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
2. For laminated-glass lites, properties are based on products of construction indicated.
3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

A. Float Glass: ASTM C 1036, Type I (transparent flat glass), Quality-Q3; of class indicated.

B. Heat-Treated Float Glass: ASTM C 1048; Type I (transparent flat glass); Quality-Q3; of class, kind, and condition indicated.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed, unless otherwise indicated.
2. Provide Kind HS (heat-strengthened) float glass in place of annealed float glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
3. For uncoated glass, comply with requirements for Condition A.
4. For coated vision glass, comply with requirements for Condition C (other uncoated glass).
5. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.

C. Insulating-Glass Units, General: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, and complying with ASTM E 774 for Class CBA units and with requirements specified in this Article and in Part 2 "Insulating-Glass Units" Article.

1. Provide Kind HS (heat-strengthened) float glass in place of annealed glass where needed to resist thermal stresses induced by differential shading of individual glass lites and to comply with glass design requirements specified in Part 1 "Performance Requirements" Article.
2. Provide Kind FT (fully tempered) glass lites where safety glass is indicated.
3. Overall Unit Thickness and Thickness of Each Lite: Dimensions indicated for insulating-glass units are nominal and the overall thicknesses of units are measured perpendicularly from outer surfaces of glass lites at unit's edge.
4. Sealing System: Dual seal, with primary and secondary sealants as follows:
   a. Manufacturer's standard sealants.
   b. Polyisobutylene and polysulfide.
   c. Polyisobutylene and silicone.
   d. Polyisobutylene and hot-melt butyl.
   e. Polyisobutylene and polyurethane.

5. Spacer Specifications: Manufacturer's standard spacer material and construction.

2.3 LAMINATED GLASS

A. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
   1. Construction: Laminate glass with polyvinyl butyral interlayer or cast-in-place and cured-transparent-resin interlayer to comply with interlayer manufacturer's written recommendations.
   2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
   3. Interlayer Color: Clear unless otherwise indicated.

B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

2.4 INSULATING GLASS

A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
   1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
   2. Spacer: Thermally broken aluminum or Nonmetallic laminate
   3. Desiccant: Molecular sieve or silica gel, or blend of both.

B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.

2.5 GLAZING GASKETS

A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
   1. Neoprene complying with ASTM C 864.
   2. EPDM complying with ASTM C 864.
   4. Thermoplastic polyolefin rubber complying with ASTM C 1115.

2.6 GLAZING SEALANTS

A. General:
1. **Compatibility**: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. **Suitability**: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.

3. **Colors of Exposed Glazing Sealants**: As selected by Architect from manufacturer's full range.

A. **Elastomeric Glazing Sealants**: Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.

1. **Single-Component Neutral-Curing Silicone Glazing Sealants**
   a. **Products**:
      1) Dow Corning Corporation; 790.
      2) GE Silicones; SilPruf LM SCS2700.
   b. **Type and Grade**: S (single component) and NS (nonsag).
   c. **Class**: 100/50.
   d. **Use Related to Exposure**: NT (nontraffic).
   e. **Uses Related to Glazing Substrates**: M, G and A

2.7 **MISCELLANEOUS GLAZING MATERIALS**

A. **General**: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. **Cleaners, Primers, and Sealers**: Types recommended by sealant or gasket manufacturer.

C. **Setting Blocks**: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. **Spacers**: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.

E. **Edge Blocks**: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. **Cylindrical Glazing Sealant Backing**: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

G. **Perimeter Insulation for Fire-Resistive Glazing**: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

H. **Security Products**: Basis of Design Product: 3M Ultra S800 Safety Film with 3M Impact Protection Adhesive Attachment System. Apply to the glazing on the door leaf and transom for door A101 only. To be installed by manufacturer's authorized installer. 3M Contact: Jeremy – 866-499-8857. A local installer is Texas Tint, Bullard, TX, 903-566-5555. Contact 3M for additional information.
2.8 FABRICATION OF GLAZING UNITS

A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.

C. Grind smooth and polish exposed glass edges and corners.

2.9 LAMINATED-GLASS TYPES

A. Glass Type GL-1: Clear laminated glass with two plies of fully tempered float glass.
   1. Locations: All interior glazing.
   2. Thickness of Each Glass Ply: 3.0 mm.
   3. Interlayer Thickness: \textit{0.060 inch (1.52 mm)}.
   4. Provide safety glazing labeling.

2.10 INSULATING-GLASS TYPES

A. Glass Type IG-1: Untinted Solar-Control Low-E Insulating-Glass Units. Basis of Design: PPG Solarban70XL (2) + Clear.

   Locations: All exterior glazing.

   1. Overall Unit Thickness and Thickness of Each Lite: 25 and 6.0 mm
   2. Interspace Content: Air
   3. Outdoor Lite: Class 1 (clear) float glass.
      a. Kind FT (fully tempered).
   4. Indoor Lite: Class 1 (clear) float glass.
      a. Kind FT (fully tempered).
   5. Low-E Coating: sputtered on third surface.
   7. Winter Nighttime U-Factor: 0.29 maximum.
   8. Summer Daytime U-Factor: 0.27 maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

   1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.3 GLAZING, GENERAL

A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
   1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
   2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 GASKET GLAZING (DRY)

A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

C. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

D. Install gaskets so they protrude past face of glazing stops.

3.5 SEALANT GLAZING (WET)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.6 CLEANING AND PROTECTION

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following types of silvered flat glass mirrors:
   1. Film-backed glass mirrors qualifying as safety glazing.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Mirrors. Include description of materials and process used to produce each type of silvered flat glass mirror specified that indicates sources of glass, glass coating components, edge sealer, and quality-control provisions.

B. Shop Drawings: Include mirror elevations, edge details, mirror hardware, and attachments to other work.

C. Samples: For each type of the following products:
   1. Mirrors:  12 inches (300 mm) square, including edge treatment on two adjoining edges.
   2. Mirror Trim:  12 inches (300 mm) long.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

B. Source Limitations for Mirrors: Obtain mirrors from single source from single manufacturer.

C. Source Limitations for Mirror Accessories: Obtain mirror glazing accessories from single source.

D. Glazing Publications: Comply with the following published recommendations:
   1. GANA's "Glazing Manual" unless more stringent requirements are indicated. Refer to this publication for definitions of glass and glazing terms not otherwise defined in this Section or in referenced standards.
   2. GANA Mirror Division's "Mirrors, Handle with Extreme Care: Tips for the Professional on the Care and Handling of Mirrors."
E. Safety Glazing Products: For film-backed mirrors, provide products complying with testing requirements in 16 CFR 1201 for Category II materials.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect mirrors according to mirror manufacturer's written instructions and as needed to prevent damage to mirrors from moisture, condensation, temperature changes, direct exposure to sun, or other causes.

B. Comply with mirror manufacturer's written instructions for shipping, storing, and handling mirrors as needed to prevent deterioration of silvering, damage to edges, and abrasion of glass surfaces and applied coatings. Store indoors.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install mirrors until ambient temperature and humidity conditions are maintained at levels indicated for final occupancy.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which mirror manufacturer agrees to replace mirrors that deteriorate within specified warranty period. Deterioration of mirrors is defined as defects developed from normal use that are not attributed to mirror breakage or to maintaining and cleaning mirrors contrary to manufacturer's written instructions. Defects include discoloration, black spots, and clouding of the silver film.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SILVERED FLAT GLASS MIRRORS

A. Glass Mirrors, General: ASTM C 1503; manufactured using copper-free, low-lead mirror coating process.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arch Aluminum & Glass Co., Inc.
b. Avalon Glass and Mirror Company.
c. Binswanger Mirror; a division of Vitro America, Inc.
d. D & W Incorporated
e. Donisi Mirror Company.
f. Gardner Glass, Inc.
g. Gilded Mirrors, Inc.
h. Guardian Industries.
i. Head West.
j. Independent Mirror Industries, Inc.
k. Lenoir Mirror Company.
l. Maran-Wurzell Glass & Mirror.
m. National Glass Industries.
n. Stroupe Mirror Co., Inc.
o. Sunshine Mirror; Westshore Glass Corp.
p. Virginia Mirror Company, Inc.
q. Walker Glass Co., Ltd.

B. Clear Glass: Mirror Glazing Quality; ultraclear (low-iron) float glass with a minimum 91 percent visible light transmission].
1. Nominal Thickness: 6.0 mm.

2.2 MISCELLANEOUS MATERIALS

A. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

B. Edge Sealer: Coating compatible with glass coating and approved by mirror manufacturer for use in protecting against silver deterioration at mirrored glass edges.

C. Mirror Mastic: An adhesive setting compound, asbestos-free, produced specifically for setting mirrors and certified by both mirror manufacturer and mastic manufacturer as compatible with glass coating and substrates on which mirrors will be installed.

D. Film Backing for Safety Mirrors: Film backing and pressure-sensitive adhesive; both compatible with mirror backing paint as certified by mirror manufacturer.

2.3 MIRROR HARDWARE

A. Top Channel/Cleat and Bottom Aluminum J-Channels: Aluminum extrusions with a return deep enough to produce a glazing channel to accommodate mirrors of thickness indicated and in lengths required to cover bottom and top edges of each mirror in a single piece.
1. Bottom Trim: J-channels formed with front leg and back leg not less than 5/16 and 3/4 inch (7.9 and 19 mm) in height, respectively.
   a. Product: Subject to compliance with requirements, provide D638 FHA Type "J" Channel by Laurence, C. R. Co., Inc.
2. Top Trim: Formed with front leg with a height of 5/16 inch (7.9 mm) and back leg designed to fit into the pocket created by wall-mounted aluminum cleat.
   a. Product: Subject to compliance with requirements, provide D 1638 Top Channel and D 1637M Mirror Mount System Cleat by Laurence, C. R. Co., Inc.

B. Plated Steel Hardware: Formed-steel shapes with plated finish indicated.
1. Profile: As indicated.
2. Finish: 05626

C. Fasteners: Fabricated of same basic metal and alloy as fastened metal and matching it in finished color and texture where fasteners are exposed.
D. Anchors and Inserts: Provide devices as required for mirror hardware installation. Provide toothed or lead-shield expansion-bolt devices for drilled-in-place anchors. Provide galvanized anchors and inserts for applications on inside face of exterior walls and where indicated.

2.4 FABRICATION

A. Mirror Edge Treatment: Rounded polished.
   1. Seal edges of mirrors with edge sealer after edge treatment to prevent chemical or atmospheric penetration of glass coating.
   2. Require mirror manufacturer to perform edge treatment and sealing in factory immediately after cutting to final sizes.

B. Film-Backed Safety Mirrors: Apply film backing with adhesive coating over mirror backing paint as recommended in writing by film-backing manufacturer to produce a surface free of bubbles, blisters, and other imperfections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, over which mirrors are to be mounted, with Installer present, for compliance with installation tolerances, substrate preparation, and other conditions affecting performance of the Work.

B. Verify compatibility with and suitability of substrates, including compatibility of mirror mastic with existing finishes or primers.

C. Proceed with installation only after unsatisfactory conditions have been corrected and surfaces are dry.

3.2 PREPARATION

A. Comply with mastic manufacturer's written installation instructions for preparation of substrates, including coating substrates with mastic manufacturer's special bond coating where applicable.

3.3 INSTALLATION

A. General: Install mirrors to comply with mirror manufacturer's written instructions and with referenced GANA publications. Mount mirrors accurately in place in a manner that avoids distorting reflected images.

B. Provide a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface for air circulation between back of mirrors and face of mounting surface.

C. Wall-Mounted Mirrors: Install mirrors with mastic and mirror hardware. Attach mirror hardware securely to mounting surfaces with mechanical fasteners installed with anchors or inserts as applicable. Install fasteners so heads do not impose point loads on backs of mirrors.
1. Top Channel/Cleat and Bottom Aluminum J-Channels: Fasten J-channel directly to wall and attach top trim to continuous cleat fastened directly to wall.

2. Install mastic as follows:
   a. Apply barrier coat to mirror backing where approved in writing by manufacturers of mirrors and backing material.
   b. Apply mastic to comply with mastic manufacturer's written instructions for coverage and to allow air circulation between back of mirrors and face of mounting surface.
   c. After mastic is applied, align mirrors and press into place while maintaining a minimum air space of 1/8 inch (3 mm) between back of mirrors and mounting surface.

3.4 CLEANING AND PROTECTION

A. Protect mirrors from breakage and contaminating substances resulting from construction operations.

B. Do not permit edges of mirrors to be exposed to standing water.

C. Maintain environmental conditions that will prevent mirrors from being exposed to moisture from condensation or other sources for continuous periods of time.

D. Wash exposed surface of mirrors not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash mirrors as recommended in writing by mirror manufacturer.

END OF SECTION 088300
SECTION 092216 - NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

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

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

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS
   A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 119 by an independent testing agency.
   B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated, according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 FRAMING SYSTEMS
   A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
      1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
   B. Studs and Runners: ASTM C 645. Use either steel studs and runners or dimpled steel studs and runners.
      1. Steel Studs and Runners:
1. Minimum Base-Metal Thickness: \(0.018\) inch \((0.45\) mm\) at interior. Use two \(0.054\) (1.37 mm) at each side of openings. Use \(0.033\) inch \((0.84\) mm\) at exterior.

b. Depth: As indicated on Drawings.

2. Dimpled Steel Studs and Runners:

a. Minimum Base-Metal Thickness: \(0.018\) inch \((0.45\) mm\) at interior. Use two \(0.054\) (1.37 mm) at each side of openings. Use \(0.033\) inch \((0.84\) mm\) at exterior.

b. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Where indicated, provide the following:

1. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.

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

1) Dietrich Metal Framing; SLP-TRK Slotted Deflection Track.
2) Steel Network Inc. (The); VertiTrack VTD Series.
3) Superior Metal Trim; Superior Flex Track System (SFT).

D. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

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

a. Fire Trak Corp.; Fire Trak System attached to studs with Fire Trak Posi Klip.
b. Grace Construction Products; FlameSafe FlowTrak System.
c. Metal-Lite, Inc.; The System.
d. Steel Network Inc. (The); VertiTrack VTD Series.

E. Steel Flexible Track: ASTM C645

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. Dietrich Industries; Contour Track
b. Flex-Ability Concepts: Flex-C Track

F. Steel Framing Clips:

1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:

a. The Claw International; “The Claw.”

G. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Metal Thickness: \(0.018\) inch \((0.45\) mm\)

H. Cold-Rolled Channel Bridging: Steel, \(0.053\)-inch \((1.34\)-mm\) minimum base-metal thickness, with minimum \(1/2\)-inch- \((13\)-mm\) wide flanges.

1. Depth: As indicated on Drawings
2. Clip Angle: Not less than \(1-1/2\) by \(1-1/2\) inches \((38 \times 38\) mm\), \(0.068\)-inch- \((1.72\)-mm\) thick, galvanized steel.
I. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
   1. Minimum Base-Metal Thickness: As indicated on Drawings or 0.033 inch (0.84 mm)
   2. Depth: As indicated on Drawings.

J. Resilient Furring Channels: 1/2-inch- (13-mm-) deep, steel sheet members designed to reduce sound transmission.

K. Cold-Rolled Furring Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: As indicated on Drawings 3/4 inch (19 mm).
   2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum uncoated-steel thickness of 0.033 inch (0.8 mm).
   3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

L. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches (32 mm), wall attachment flange of 7/8 inch (22 mm), minimum uncoated-metal thickness of 0.018 inch (0.45 mm), and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch- (1.59-mm-) diameter wire, or double strand of 0.048-inch- (1.21-mm-) diameter wire.

B. Hanger Attachments to Concrete:
   1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
      a. Type: Postinstalled, chemical anchor or Postinstalled, expansion anchor.

C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.16 inch (4.12 mm) in diameter.

D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.053 inch (1.34 mm) and minimum 1/2-inch- (13-mm-) wide flanges.
   1. Depth: As indicated on Drawings

E. Furring Channels (Furring Members):
   1. Cold-Rolled Channels: 0.053-inch (1.34-mm) uncoated-steel thickness, with minimum 1/2-inch- (13-mm-) wide flanges, 3/4 inch (19 mm) deep.
   2. Steel Studs and Runners: ASTM C 645.
      a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm).
      b. Depth: As indicated on Drawings.
   a. Minimum Base-Metal Thickness: 0.025 inch (0.64 mm).
   b. Depth: As indicated on Drawings.

4. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch (22 mm) deep.
   a. Minimum Base-Metal Thickness: 0.033 inch (0.84 mm)

5. Resilient Furring Channels: 1/2-inch- (13-mm-) deep members designed to reduce sound transmission.
   a. Configuration: Asymmetrical or hat shaped.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:
   b. Chicago Metallic Corporation; Drywall Grid System.
   c. USG Corporation; Drywall Suspension System.

2.4 AUXILIARY MATERIALS
   A. General: Provide auxiliary materials that comply with referenced installation standards.

1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

B. Isolation Strip at Exterior Walls: Provide the following:

1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch (3.2 mm) thick, in width to suit steel stud size.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.

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

3.2 PREPARATION
   A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure
have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.

1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination with Sprayed Fire-Resistive Materials:

1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling runners (tracks) to surfaces indicated to receive sprayed fire-resistive materials. Where offset anchor plates are required, provide continuous plates fastened to building structure not more than 24 inches (610 mm) o.c.
2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

3.3 INSTALLATION, GENERAL

A. Installation Standard: ASTM C 754.

1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

C. Install bracing at terminations in assemblies.

D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING FRAMED ASSEMBLIES

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

1. Single-Layer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
2. Multilayer Application: 16 inches (406 mm) o.c. unless otherwise indicated.
3. Tile Backing Panels: 16 inches (406 mm) o.c. unless otherwise indicated.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.
D. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
   a. Install two studs at each jamb unless otherwise indicated.
   b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (13-mm) clearance from jamb stud to allow for installation of control joint in finished assembly.
   c. Extend jamb studs through suspended ceilings and attach to underside of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
   a. Firestop Track: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
6. Curved Partitions:
   a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
   b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches (150 mm) o.c.

E. Direct Furring:

1. Screw to wood framing.
2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.

F. Z-Furring Members:

1. Erect insulation, specified in Division 07 Section "Thermal Insulation," vertically and hold in place with Z-furring members spaced 24 inches (610 mm) o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches (610 mm) o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attachment short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches (305 mm) from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.
3.5 INSTALLING SUSPENSION SYSTEMS

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

1. Hangers: 48 inches (1219 mm) o.c.
2. Carrying Channels (Main Runners): 48 inches (1219 mm) o.c.
3. Furring Channels (Furring Members): 16 inches (406 mm) o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
   a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
   a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.

4. Do not attach hangers to steel roof deck.

5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.

6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet (3 mm in 3.6 m) measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

END OF SECTION 092216
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior gypsum board.
2. Tile backing panels.
3. Texture finishes.

B. Related Requirements:

1. Division 06 Section "Sheathing" for gypsum sheathing for exterior walls.
2. Division 09 Section "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.
3. Division 09 Section "Tiling" for cementitious backer units installed as substrates for ceramic tile.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 QUALITY ASSURANCE

A. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. (9 sq. m) in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Install mockups for the following:
   a. Each level of gypsum board finish indicated for use in exposed locations.
   b. Each texture finish indicated.

2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE AND HANDLING
A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.

   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
   2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   1. American Gypsum.
   2. CertainTeed Corp.
   3. Georgia-Pacific Gypsum LLC.
   4. Lafarge North America Inc.
   6. PABCO Gypsum.
   7. Temple-Inland.
   8. USG Corporation.
B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
   1. Thickness: 5/8 inch (15.9 mm).
   2. Long Edges: Tapered.

C. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M.
   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Long Edges: Tapered.

D. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Long Edges: Tapered.

2.4 SPECIALTY GYPSUM BOARD

A. Glass-Mat Interior Gypsum Board: ASTM C 1658/C 1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Georgia-Pacific Gypsum LLC; DensArmour Plus.
      b. Temple-Inland: GreenGlass Interior Gypsum Board.
   2. Core: 5/8 inch (15.9 mm), Type X.

B. Acoustically Enhanced Gypsum Board: ASTM C 1396/C 1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.
   1. Core: 5/8 inch (15.9 mm), Type X.
   2. Long Edges: Tapered.

2.5 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
   1. Products: Subject to compliance with requirements, use one of the following:
      a. C-Cure; C-Cure Board 990.
      b. CertainTeed Corp.; FiberCement BackerBoard.
      c. Custom Building Products; Wonderboard.
      d. FinPan, Inc.; Util-A-Crete Concrete Backer Board.
      e. James Hardie Building Products, Inc.; Hardiebacker 500.
      g. USG Corporation; DUROCK Cement Board.
2. Thickness: 5/8 inch (15.9 mm).

2.6 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.
   1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
   2. Shapes:
      a. Cornerbead.
      b. LC-Bead: J-shaped; exposed long flange receives joint compound.
      c. Expansion (control) joint.
      d. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
   1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221 (ASTM B 221M), Alloy 6063-T5.
   2. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

2.7 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:
   1. Interior Gypsum Board: Paper.
   2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
   1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
   2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
   3. Fill Coat: For second coat, use drying-type, all-purpose compound.
   4. Finish Coat: For third coat, use drying-type, all-purpose compound.
   5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.

D. Joint Compound for Tile Backing Panels:
   1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.8 AUXILIARY MATERIALS
A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

B. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
   1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
   2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

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

2.9 TEXTURE FINISHES

A. Primer: As recommended by textured finish manufacturer.

B. Non-Aggregate Finish: Pre-mixed, vinyl texture finish for spray application.
   1. Texture: Orange Peel
   2. Provide level 5 smoothness at projection surfaces.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, for compliance with requirements and other conditions affecting performance.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

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

3.2 APPLYING AND FINISHING PANELS, GENERAL

A. Comply with ASTM C 840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch (1.5 mm) of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered
edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. (0.7 sq. m) in area.
2. Fit gypsum panels around ducts, pipes, and conduits.
3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch (6.4- to 9.5-mm) wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch (6.4- to 12.7-mm) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.

J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

3.3 APPLYING INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: All Vertical surfaces unless otherwise indicated.
2. Abuse-Resistant Type: All mechanical, storage, and closets.
3. Moisture- and Mold-Resistant Type: All toilet rooms and janitor rooms except behind ceramic tile.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

   a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
   b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:
   1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
   2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
   3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
   4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

D. Curved Surfaces:
   1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch (300 mm) long straight sections at ends of curves and tangent to them.
   2. For double-layer construction, fasten base layer to studs with screws 16 inches (400 mm) o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches (300 mm) o.c.

3.4 APPLYING TILE BACKING PANELS
A. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated.
B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.5 INSTALLING TRIM ACCESSORIES
A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
B. Interior Trim: Install in the following locations:
   1. Cornerbead: Use at outside corners.
   2. LC-Bead: Use at exposed panel edges.
   3. Curved-Edge Cornerbead: Use at curved openings.
C. Aluminum Trim: Install in locations indicated on Drawings.

3.6 FINISHING GYPSUM BOARD
A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:

1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
2. Level 2: Panels that are substrate for tile or Panels that are substrate for acoustical tile.
3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.
4. Level 5: Where indicated on Drawings.
   a. Primer and its application to surfaces are specified in other Division 09 Sections.

E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.7 APPLYING TEXTURE FINISHES

A. Surface Preparation and Primer: Prepare and apply primer to gypsum panels and other surfaces receiving texture finishes. Apply primer to surfaces that are clean, dry, and smooth.

B. Texture Finish Application: Mix and apply finish using powered spray equipment, to produce a uniform texture, matching approved mockup, free of starved spots or other evidence of thin application or of application patterns.

C. Prevent texture finishes from coming into contact with surfaces not indicated to receive texture finish by covering them with masking agents, polyethylene film, or other means. If, despite these precautions, texture finishes contact these surfaces, immediately remove droppings and overspray to prevent damage according to texture-finish manufacturer's written recommendations.

3.8 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
   1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900
SECTION 093000 - TILING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Ceramic tile.
2. Tile backing panels.
3. Metal edge strips.

B. Related Sections:

1. Division 07 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
2. Division 09 Section "Gypsum Board" for cementitious backer.

1.3 DEFINITIONS

A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.


C. Module Size: Actual tile size plus joint width indicated.

D. Face Size: Actual tile size, excluding spacer lugs.

1.4 PERFORMANCE REQUIREMENTS

A. Static Coefficient of Friction: For tile installed on walkway surfaces, provide products with the following values as determined by testing identical products per ASTM C 1028:

1. Level Surfaces: Minimum 0.6.
2. Step Treads: Minimum 0.6
3. Ramp Surfaces: Minimum 0.8

1.5 ACTION SUBMITTALS
A. Product Data: For each type of product indicated.

B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.

C. Samples for Initial Selection: For each type of tile and grout indicated. Include Samples of accessories involving color selection.

1.6 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.

2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

1.7 QUALITY ASSURANCE

A. Source Limitations for Tile: Obtain tile of each type and color or finish from one source or producer.

1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from one manufacturer and each aggregate from one source or producer.

C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer for each product:

1. Joint sealants.
2. Cementitious backer units.
3. Metal edge strips.

D. Preinstallation Conference: Conduct conference at Project site.

1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.

B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.

C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
D. Store liquid materials in unopened containers and protected from freezing.

E. Handle tile that has temporary protective coating on exposed surfaces to prevent coated surfaces from contacting backs or edges of other units. If coating does contact bonding surfaces of tile, remove coating from bonding surfaces before setting tile.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

PART 2 - PRODUCTS

2.1 PRODUCTS, GENERAL

A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.

1. Provide tile complying with Standard grade requirements unless otherwise indicated.

B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.

C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.

E. Factory-Applied Temporary Protective Coating: Where indicated under tile type, protect exposed surfaces of tile against adherence of mortar and grout by precoating with continuous film of petroleum paraffin wax, applied hot. Do not coat unexposed tile surfaces.

2.2 TILE PRODUCTS

1. See Finish Legend

2.3 TILE BACKING PANELS

A. Cementitious Backer Units: ANSI A118.9 or ASTM C 1325, in maximum lengths available to minimize end-to-end butt joints.

1. Thickness: 5/8 inch (15.9 mm).

2.4 SETTING MATERIALS

1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
2. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.

2.5 GROUT MATERIALS

A. Water-Cleanable Epoxy Grout: ANSI A118.3.
   1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to $140 \text{ deg F}$ ($60 \text{ deg C}$) and $212 \text{ deg F}$ ($100 \text{ deg C}$), respectively, and certified by manufacturer for intended use.

2.6 Grout for Pregouted Tile Sheets: Same product used in factory to pregrout tile sheets.

2.7 ELASTOMERIC SEALANTS

A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."
   1. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.

B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.

C. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior ceramic tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.

D. Multipart, Pourable Urethane Sealant for Use T: ASTM C 920; Type M; Grade P; Class 25; Uses T, M, A, and, as applicable to joint substrates indicated, O.

E. Chemical-Resistant Sealants: For chemical-resistant floors, provide chemical-resistant elastomeric sealant of type recommended and produced by chemical-resistant mortar and grout manufacturer for type of application indicated, with proven service record and compatibility with tile and other setting materials, and with chemical resistance equivalent to mortar/grout.

2.8 MISCELLANEOUS MATERIALS

A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.

B. Metal Edge Strips: Angle or L-shape, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; aluminum exposed-edge material.
C. Temporary Protective Coating: Either product indicated below that is formulated to protect exposed surfaces of tile against adherence of mortar and grout; compatible with tile, mortar, and grout products; and easily removable after grouting is completed without damaging grout or tile.

1. Petroleum paraffin wax, fully refined and odorless, containing at least 0.5 percent oil with a melting point of 120 to 140 deg F (49 to 60 deg C) per ASTM D 87.
2. Grout release in form of manufacturer's standard proprietary liquid coating that is specially formulated and recommended for use as temporary protective coating for tile.

D. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

E. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints and that does not change color or appearance of grout.

2.9 MIXING MORTARS AND GROUT

A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.

B. Add materials, water, and additives in accurate proportions.

C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.

1. Verify that substrates for setting tile are firm, dry, clean, free of coatings that are incompatible with tile-setting materials including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
2. Verify that concrete substrates for tile floors installed with bonded mortar bed or thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
   a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
   b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.

B. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot (1:50) toward drains.

C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

D. Field-Applied Temporary Protective Coating: If indicated under tile type or needed to prevent grout from staining or adhering to exposed tile surfaces, precoat them with continuous film of temporary protective coating, taking care not to coat unexposed tile surfaces.

3.3 TILE INSTALLATION

A. Comply with TCA's "Handbook for Ceramic Tile Installation" for TCA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 Series "Specifications for Installation of Ceramic Tile" that are referenced in TCA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.

1. For the following installations, follow procedures in the ANSI A108 Series of tile installation standards for providing 95 percent mortar coverage:
   a. Tile floors composed of tiles 8 by 8 inches (200 by 200 mm) or larger.
   b. Tile floors composed of rib-backed tiles.

B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.

C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.

D. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.

1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
E. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:

1. Ceramic Mosaic Tile: 1/16 inch (1.6 mm).
2. Quarry Tile: [1/4 inch (6.35 mm)] [3/8 inch (9.5 mm)].
3. Paver Tile: [1/4 inch (6.35 mm)] [3/8 inch (9.5 mm)].
4. Glazed Wall Tile: 1/16 inch (1.6 mm).
5. Decorative Thin Wall Tile: 1/16 inch (1.6 mm).

F. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

G. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile.

H. Grout Sealer: Apply grout sealer to grout joints in tile floors according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

3.4 TILE BACKING PANEL INSTALLATION

A. Install cementitious backer units and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use latex-portland cement mortar for bonding material unless otherwise directed in manufacturer's written instructions.

3.5 CLEANING AND PROTECTING

A. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.

1. Remove epoxy and latex-portland cement grout residue from tile as soon as possible.
2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
3. Remove temporary protective coating by method recommended by coating manufacturer and that is acceptable to tile and grout manufacturer. Trap and remove coating to prevent drain clogging.

B. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.

C. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
D. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

END OF SECTION 093000
SECTION 093050 – TILE SETTING MATERIALS AND ACCESSORIES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Edge-protection and transition profiles for floors.
B. Setting materials: adhesives, mortars, grouts, and sealants.

1.2 RELATED SECTIONS

A. Section 033000 - Cast-in-Place Concrete.
B. Section 061053 - Miscellaneous Rough Carpentry.
C. Section 092900 - Gypsum Board.
D. Section 093000 - Tiling.

1.3 REFERENCES

A. CSA B79-08: Floor, Area, and Shower Drains, and Cleanouts for Residential Construction.

1.4 SUBMITTALS

A. Submit under provisions of Section 013000.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.
C. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and finish.
D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum ten years experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum five years experience.
C. Source Limitations for Setting Materials and Accessories: Obtain product of a uniform quality
for each application condition from a single manufacturer.

D. **Mock-Up:** Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
   1. Finish areas designated by Architect.
   2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
   3. Refinish mock-up area as required to produce acceptable work.

E. **Preinstallation Conference:** Conduct conference at the Project site.
   1. Convene one week prior to commencing work of this section.
   2. Require attendance of installation material manufacturer, tile supplier, tile installer and installers of related work. Review installation procedures and coordination required with related work.
   3. Meeting agenda includes but is not limited to:
      a. Surface preparation.
      b. Tile and installation material compatibility.
      c. Edge protection, transition and pre-fabricated movement joint profiles.
      d. Waterproofing techniques.
      e. Crack isolation techniques.

1.6 **DELIVERY, STORAGE, AND HANDLING**

A. Store products in manufacturer’s unopened packaging until ready for installation.

B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.

C. Store materials in a dry, warm, ventilated weathertight location.

1.7 **PROJECT CONDITIONS**

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer’s absolute limits.

1.8 **COORDINATION**

A. Coordinate Work with other operations and installation of floor finish materials to avoid damage to installed materials.

**PART 2 PRODUCTS**

2.1 **MANUFACTURERS**

A. **Acceptable Manufacturer:** Schluter Systems, L.P., 194 Pleasant Ridge Road, Plattsburgh, NY 12901-5841. ASD. Tel: (800) 472-4588. Fax (800) 477-9783. E-mail: specassist@schluter.com. Web: www.schluter.com.

B. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00.

2.2 **EDGE-PROTECTION AND TRANSITION PROFILES FOR FLOORS**

A. **Schluter-SCHIENE**
   1. Description: L-shaped profile with 1/8 inch (3.2 mm) wide visible surface integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.
   2. Material and Finish:
a. As selected by architect from manufacturers full range.
   1) Height as required to coordinate with tile selection and setting system selected.

B. Schluter-RENO-TK
   1. Description: profile with sloped exposed surface, 1/4 inch (6 mm) deep channel below exposed surface, integrated trapezoid-perforated anchoring leg, and integrated grout joint spacer.
   2. Material and Finish:
      a. As selected by architect from manufacturers full range.
         1) Height as required to coordinate with tile selection and setting system selected.

2.3 SETTING MATERIALS
   A. Installation methods as specified in Section 093000 - Tiling.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION
   A. Clean surfaces thoroughly prior to installation.
   B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION
   A. Install in accordance with manufacturer's instructions.

3.4 PROTECTION
   A. Protect installed products until completion of project.
   B. Touch-up, repair or replace damaged products before Substantial Completion.

END OF SECTION 093050
SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes acoustical panels and exposed suspension systems for ceilings.
   B. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

1.3 PREINSTALLATION MEETINGS
   A. Preinstallation Conference: Conduct conference at Project site.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product.
   B. Samples: For each exposed product and for each color and texture specified, 6 inches (150 mm) in size.
   C. Samples for Initial Selection: For components with factory-applied color finishes.

1.5 INFORMATIONAL SUBMITTALS
   A. Product Test Reports: For each acoustical panel ceiling, for tests performed by manufacturer and witnessed by a qualified testing agency or a qualified testing agency.

1.6 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For finishes to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS
   A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
      1. Acoustical Ceiling Panels: Full-size panels equal to 2 percent of quantity installed.
      2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
3. Hold-Down Clips: Equal to 2 percent of quantity installed.
4. Impact Clips: Equal to 2 percent of quantity installed.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

B. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

2.2 ACOUSTICAL PANELS, GENERAL

A. Source Limitations:

1. Acoustical Ceiling Panel: Obtain each type from single source from single manufacturer.
2. Suspension System: Obtain each type from single source from single manufacturer.

B. Source Limitations: Obtain each type of acoustical ceiling panel and supporting suspension system from single source from single manufacturer.
C. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.

D. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches (400 mm) away from test surface according to ASTM E 795.

E. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.

1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.

2.3 ACOUSTICAL PANELS: As scheduled.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

   a. Type: Postinstalled expansion or Postinstalled bonded anchors.
   b. Corrosion Protection: Stainless-steel components complying with ASTM F 593 and ASTM F 594, Group 1 Alloy 304 or 316 for bolts; Alloy 304 or 316 for anchor.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- (2.69-mm-) diameter wire.

D. Hold-Down Clips: Where indicated, provide manufacturer’s standard hold-down clips spaced 24 inches (610 mm) o.c. on all cross tees.

E. Impact Clips: Where indicated, provide manufacturer’s standard impact-clip system designed to absorb impact forces against acoustical panels.

F. Clean-Room Gasket System: Where indicated, provide manufacturer’s standard system, including manufacturer’s standard gasket and related adhesives, tapes, seals, and retention clips, designed to seal out foreign material from and maintain positive pressure in clean room.

2.5 METAL SUSPENSION SYSTEM: As scheduled.

2.6 METAL EDGE MOLDINGS AND TRIM: As scheduled to match metal suspension system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

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

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer’s written instructions and CISCA’s "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building’s structural members and as follows:
1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
6. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
7. Do not attach hangers to steel deck tabs.
8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
9. Space hangers not more than 48 inches (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) from ends of each member.
10. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building’s structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches (400 mm) o.c. and not more than 3 inches (75 mm) from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet (3.2 mm in 3.6 m). Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. Arrange directionally patterned acoustical panels as follows:
   a. As indicated on reflected ceiling plans.
2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.

5. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.

6. Install clips in areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer’s written instructions unless otherwise indicated.

7. Install clean-room gasket system in areas indicated, sealing each panel and fixture as recommended by panel manufacturer’s written instructions.

8. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer’s written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION 095113
SECTION 096513 - RESILIENT BASE AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Resilient base.
2. Resilient molding accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples for Initial Selection: For each type of product indicated.
C. Product Schedule: For resilient products. Use same designations indicated on Drawings.

1.4 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Furnish not less than 10 linear feet (3 linear m) for every 500 linear feet (150 linear m) or fraction thereof, of each type, color, pattern, and size of resilient product installed.

1.5 QUALITY ASSURANCE

A. Fire-Test-Response Characteristics: As determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.

1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F (10 deg C) or more than 90 deg F (32 deg C).

1.7 PROJECT CONDITIONS
A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F in spaces to receive resilient products during the following time periods:
   1. 48 hours before installation.
   2. During installation.
   3. 48 hours after installation.

B. Until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

C. Install resilient products after other finishing operations, including painting, have been completed.

PART 2 - PRODUCTS

2.1 RESILIENT BASE
   
      1. Manufacturers: Provide products as described on finish legend.
   
   B. Minimum Thickness: 0.125 inch (3.2 mm).
   
   C. Height: As scheduled.
   
   D. Lengths: Coils in manufacturer's standard length.
   
   E. Outside Corners: Job formed.
   
   F. Inside Corners: Job formed.
   
   G. Colors and Patterns: As scheduled on finish legend.

2.2 RESILIENT MOLDING ACCESSORY
   
   A. Description: Resilient Shoe Molding
   
   B. Material: Rubber.
   
   C. Profile and Dimensions: As scheduled on finish legend.
   
   D. Colors and Patterns: As scheduled on finish legend.

2.3 INSTALLATION MATERIALS
   
   A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by manufacturer for applications indicated.
   
   B. Adhesives: Water-resistant type recommended by manufacturer to suit resilient products and substrate conditions indicated.
C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of tiles, and in maximum available lengths to minimize running joints.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

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

3.2 PREPARATION

A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates for Resilient Stair Treads and Accessories: Prepare according to ASTM F 710.
   1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
   2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
   3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer.
   4. Moisture Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrates pass testing.

C. and patching compound and remove bumps and ridges to produce a uniform and smooth substrate.

D. Do not install resilient products until they are same temperature as the space where they are to be installed.
   1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.

E. Sweep and vacuum clean substrates to be covered by resilient products immediately before installation.

3.3 RESILIENT BASE INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient base.

B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
C. Install resilient base in lengths as long as practicable without gaps at seams and with tops of adjacent pieces aligned.

D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.

E. Do not stretch resilient base during installation.

F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.

G. Job-Formed Corners:
   1. Outside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at bends.
   2. Inside Corners: Use straight pieces of maximum lengths possible.

3.4 RESILIENT ACCESSORY INSTALLATION

A. Comply with manufacturer's written instructions for installing resilient accessories.

B. Resilient Stair Accessories:
   1. Tightly adhere to substrates throughout length of each piece.
   2. For treads installed as separate, equal-length units, install to produce a flush joint between units.

C. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of carpet or resilient floor covering that would otherwise be exposed.

3.5 CLEANING AND PROTECTION

A. Comply with manufacturer's written instructions for cleaning and protection of resilient products.

B. Perform the following operations immediately after completing resilient product installation:
   1. Remove adhesive and other blemishes from exposed surfaces.
   2. Sweep and vacuum surfaces thoroughly.
   3. Damp-mop surfaces to remove marks and soil.

C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.

D. Floor Polish: Remove soil, visible adhesive, and surface blemishes from resilient stair treads before applying liquid floor polish.
   1. Apply number of coat(s) to match Owner's maintenance program.

E. Cover resilient products until Substantial Completion.

END OF SECTION 096513
SECTION 096616 – TERRAZZO FLOOR TILE

PART 1 – GENERAL

1.01 SUMMARY

A. Section includes: Terrazzo floor tile covering and accessories.

B. Related requirements:
   1. Drawings and General Provisions of the Contract (including General and Supplementary Conditions and Division 1 References Section)
   2. Section 03: Concrete (subfloors)
   3. Section 07: Thermal and moisture protection

1.02 REFERENCE STANDARDS

A. ASTM International
   1. C 1028 Standard Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces by the Horizontal Dynamometer Pull-Meter Method
   2. D 2240 Standard Test Method for Durometer Hardness
   6. F 970 Standard Test Method for Static Load Limit
   7. F 1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride
   8. F 2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using In Situ Probes

B. European Norms (EN)
   1. EN 1815 Static electric Propensity
   2. Residual Indentation after Static Load

C. Other referenced documents

1.03 ADMINISTRATIVE REQUIREMENTS

A. Coordination: Install floor covering after finishing operations, including painting and ceiling operations, have been completed.

B. Pre-installation Meetings: Meet to confirm project requirements, substrate conditions, manufacturer’s installation instructions and warranty requirements in compliance with Division 1 requirements.

C. Sequencing: Do not install floor covering over concrete substrates until substrates have cured and are dry to bond with adhesive as determined using test methods specified in ASTM F710 and following adhesive manufacturer’s instructions.

1.04 ACTION SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures.

C. Samples: Submit selection and verification samples showing the required style and color for flooring as well as cove or sanitary base, stair treads and wall protection units

1.05 INFORMATION SUBMITTALS

A. Test and Evaluation Reports
   1. Product test reports: As required by Conditions of the Contract and Division 1 Regulatory Requirements Section, submit test certificates from an independent test laboratory showing compliance with specified performance characteristics and physical properties.
   2. Compatibility and adhesion test reports: Submit test reports confirming adhesive’s effectiveness with the product(s) specified.


1.06 CLOSEOUT SUBMITTALS


1.07 QUALITY ASSURANCE

A. Installer: To be qualified to install the material, installer shall fulfill one of the following requirements.
   1. The Installing company shall utilize installers that are certified on the applicable Floorazzo installation process (Butt or Fusion Technique) by the supplier. Installers must be able to provide valid Certification documentation at the time of installation start.
   2. Installer shall hire the manufacturer’s representative to provide a minimum of 2 days of training and onsite supervision. Training shall be conducted prior to the start of the installation. Installing company shall provide installers ample time to participate in the training and certification process. This shall be included in the price of the installation from the Flooring Contractor.

B. Testing Agency: Agency shall be independent and qualified to perform concrete substrate moisture and humidity testing according to ASTM F710 prior to the flooring being installed.

C. Preconstruction Testing:
   1. Concrete substrate: Reference Standard ASTM F710 for more detail. To partially summarize here, regardless of its age or grade level or history of use, perform the following concrete tests:
      i. Concrete Moisture Test: Perform moisture tests (ASTM F1869 and ASTM F2170) on concrete with a minimum of three tests for the first 1000 square feet and one additional test for each 1000 square feet or fraction thereof. A diagram of the area showing the location and results of each test shall be dated and submitted to the architect, general contractor, and/or end user. If test results exceed the floor covering manufacturer’s limits, installation shall not commence until results conform to limits.
      ii. If test results on installations exceed the following limits, installation shall not commence until results conform to limits:

<table>
<thead>
<tr>
<th>Standard</th>
<th>Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perma-Bond</td>
<td></td>
</tr>
<tr>
<td>ASTM F 1869</td>
<td>6 lbs/1000 sq ft/24 hrs</td>
</tr>
<tr>
<td>ASTM F 2170</td>
<td>82% relative humidity</td>
</tr>
</tbody>
</table>
      iii. Concrete pH Test: Perform pH tests on concrete. Readings below 7.0 and above 10.0 can adversely affect resilient flooring or adhesives, or both.

1.08 DELIVERY, STORAGE, AND HANDLING

A. General: Comply with Division 1 Product Requirements Section

B. Delivery and Acceptance Requirements: Comply with the product supplier’s ordering and lead time requirements to avoid construction delays, and to allow material to acclimatize as required in the specified product’s installation instructions. Accept delivery of materials only if they are in unopened,
undamaged packaging that bears the name and brand of the manufacturer/product supplier, project identification, and shipping and handling instructions.

C. Storage and Handling Requirements: Upon receiving floor covering, immediately remove from pallet and lay on a flat surface. Store material -- including underlayment panels, patching or underlayment compound, floor covering material and adhesive -- in the original packaging (as delivered) in areas that are enclosed and weather tight with the permanent HVAC system set at a temperature of between 65°F and 80°F for a minimum of 48 hours prior to commencement of installation. In addition, comply with storage and handling requirements listed on product packaging, and described in the latest edition of the product's installation instructions (available from www.matsinc.com).

1.09 AMBIENT SITE CONDITIONS

The permanent HVAC system shall be operational and set at a temperature of between 65°F and 80°F for a minimum of 48 hours prior to commencement of installation, during the time of installation, and for 48 hours after installation has been completed. Thereafter, minimum temperature shall be 55°F. Refer to the latest version of the installation instructions (available from www.matsinc.com) for additional ambient requirements (humidity, completion of related work or substrates, etc.) under which the work must be performed in order for the work results to provide the specified quality.

PART 2 – PRODUCTS

2.01 MANUFACTURERS

A. Supplier: Floorazzo by Mats Inc., 37 Shuman Avenue, Stoughton, MA 02072; telephone: 1.800.MATS.INC (1.800.628.7462); fax: 1.781.344.1537; email: info@matsinc.com; website: www.matsinc.com.

B. Product shall be Precast Terrazzo Tile product made with Polyester Resins for flexibility of installation. Products made from Epoxy Resins or Cementitious Materials shall not be allowed. Product must be designed for installation with resilient adhesive; thin-set and grouting is not allowed.

C. Obtain all materials including tile, adhesive, Fusion, etc from one single manufacturer

D. Product Installation Type:

1. Fusion: Larger 24" x 24" Terrazzo Tile (or) Larger 24" x 48" Terrazzo Panels shall be installed using Fusion Technique where tiles are bonded to each other to provide a seamless floor.

E. Substitutions: no substitutions permitted.

F. Product Options

1. Floorazzo Marble – Panels 24" x 48"

   Size: 24" x 48"

   Weight: 2.15 lb/sq ft

   Gauge: 3/16"

   Edges: Straight

   Install: Fusion

   Colors: Glacier

G. Performance: Physical properties of Floorazzo Tiles shall conform to the following minimums:

<table>
<thead>
<tr>
<th>Category</th>
<th>Standard</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>ASTM E648</td>
<td>Class 1</td>
</tr>
<tr>
<td>Critical radiant flux</td>
<td>ASTM E662</td>
<td>Pass</td>
</tr>
<tr>
<td>Smoke density</td>
<td>ASTM C1028</td>
<td>Wet: 0.7; Dry: 0.66</td>
</tr>
<tr>
<td>Slip resistance</td>
<td>ASTM F970</td>
<td>1,000 psi</td>
</tr>
<tr>
<td>Chemical resistance</td>
<td>ASTM F925</td>
<td>No change</td>
</tr>
</tbody>
</table>
2.02 ACCESSORY PRODUCTS
A. Adhesive: Mats Inc. Perma-Bond adhesive with a 1/16” x 1/16” x 1/16” square notched trowel.
B. Sealer: Apply a penetrating sealer i.e. Hillyard Terrazine. Further instructions can be found in the latest edition of the installation instructions (available from www.matsinc.com).
C. Floor Finish: Hillyard North Star floor finish can be applied immediately after the sealer is dry. Further instructions can be found in the latest edition of the installation instructions (available from www.matsinc.com).
D. Cleaning Products: Use a neutral cleaner and follow manufacturer’s instructions for mopping and auto scrubbing. Further instructions can be found in the latest edition of the installation instructions (available from www.matsinc.com).

PART 3 – EXECUTION
3.01 EXAMINATION
A. Overall: Follow guidelines laid out in Division 01, Section 01 71 00 – Examination and Preparation as well as Section 01 43 00 – Quality Assurance.
B. Verification of Conditions: Inspect all substrates and subfloors for proper tolerances and dryness, and report any discrepancies to the general contractor in writing.
C. Pre-installation Testing: Verify that concrete testing per ASTM F710 has been conducted by an independent testing agency, and that results are within the adhesive and floor covering manufacturers’ requirements.
D. Evaluation and Assessment: See the state requirements for the project location.
E. Proper storage and acclimation of product according to manufacturer’s procedures

3.02 SURFACE PREPARATION
A. Follow guidelines laid out in Division 01, Section 01 71 00 – Examination and Preparation.
B. Prepare concrete substrates per ASTM F 710. All work required to put the concrete subfloor in acceptable condition shall be the responsibility of the general contractor. See the state requirements for the project location.
C. Close adherence to the manufacturer requirements for floor levelness and preparation.

3.03 INSTALLATION
A. Follow Division 01 relevant guidelines, and the latest edition of the manufacturer’s installation instructions (available from www.matsinc.com). Only use written instructions from the manufacturer.
B. Interface with Other Work: If transitions are required to and/or from the specified floor covering, contact the supplier for suitable transition material.

3.04 FIELD QUALITY CONTROL
A. Field Tests: this is for installed work (after job is done)
B. Manufacturer Services: Coordinate with supplier if an on-site manufacturer’s representative is required. Installers without prior experience must have manufacturer’s representative on site for training and oversight as required by the manufacturer.

3.05 CLEANING
A. General: Clean up job site, including sweeping or dust mopping the floor to remove all dirt or grit, and put all waste in general contractor’s dumpster. Follow overall cleaning guidelines described in Division 01.
B. Initial Maintenance: Installer is responsible and must conduct the initial penetrating floor sealer and surface treatment. It must be conducted immediately after installation.

C. Initial maintenance shall be per the latest edition of the manufacturer’s maintenance instructions (available from www.matsinc.com)

3.06 CLOSEOUT ACTIVITIES

Follow stated requirements and Division 01 Section 01 76 00 – Protecting Installed Construction and Section 01 78 00 – Closeout Submittals requirements for these activities.

END OF SECTION 096616
SECTION 096813 - TILE CARPETING

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section includes modular, carpet tile.
B. Related Requirements:
   1. Division 09 Section "Resilient Base and Accessories" and "Resilient Tile Flooring" for resilient wall base and accessories installed with carpet tile.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
      a. Review delivery, storage, and handling procedures.
      b. Review ambient conditions and ventilation procedures.
      c. Review subfloor preparation procedures.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
   2. Include installation recommendations for each type of substrate.
B. Shop Drawings: Show the following:
   1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
   2. Carpet tile type, color, and dye lot.
   3. Type of subfloor.
   4. Type of installation.
   5. Pattern of installation.
   6. Pattern type, location, and direction.
   7. Pile direction.
   8. Type, color, and location of insets and borders.
   9. Type, color, and location of edge, transition, and other accessory strips.
   10. Transition details to other flooring materials.
C. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS
A. Qualification Data: For Installer.
B. Sample Warranty: For special warranty.

1.6 MAINTENANCE MATERIAL SUBMITTALS
A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   
   1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

1.7 QUALITY ASSURANCE
A. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.
B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
   
   1. Build mockups at locations and in sizes shown on Drawings.
   2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING
A. Comply with CRI 104.

1.9 FIELD CONDITIONS
A. Comply with CRI 104 for temperature, humidity, and ventilation limitations.
B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at occupancy levels during the remainder of the construction period.
C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

PART 2 - PRODUCTS
2.1 CARPET TILE: As scheduled

2.2 INSTALLATION ACCESSORIES

A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.

B. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

   1. Basis-of-Design

      a. Schluter Systems; Schluter-SCHIENE at transition from ceramic tile to carpet
      b. Schluter Systems; Schluter-RENO-U at transition from ceramic tile to resilient tile

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance. Examine carpet tile for type, color, pattern, and potential defects.

B. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:

   1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
   2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
   3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.

C. For wood subfloors, verify the following:

   1. Underlayment over subfloor complies with requirements specified in Division 06 Section "Rough Carpentry."
   2. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.

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

3.2 PREPARATION

A. General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm) unless more stringent requirements are required by manufacturer's written instructions.

C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by carpet tile manufacturer.

D. Clean metal substrates of grease, oil, soil and rust, and prime if directed by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.

E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

3.3 INSTALLATION

A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.

B. Installation Method: As recommended in writing by carpet tile manufacturer.

C. Maintain dye lot integrity. Do not mix dye lots in same area.

D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.

E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.

G. Install pattern parallel to walls and borders.

3.4 CLEANING AND PROTECTION

A. Perform the following operations immediately after installing carpet tile:

1. Remove yarns that protrude from carpet tile surface.
2. Vacuum carpet tile using commercial machine with face-beater element.

B. Protect installed carpet tile to comply with CRI 104, Section 16, "Protecting Indoor Installations."

C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

END OF SECTION 096813
SECTION 097200 - WALL COVERINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Vinyl wall covering.

B. Related Sections:
   1. Division 09 Section "Interior Painting" for priming wall surfaces.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include data on physical characteristics, durability, fade resistance, and flame-resistance characteristics.

B. Shop Drawings: Show location and extent of each wall-covering type. Indicate pattern placement, veneer matching, seams and termination points.

C. Samples for Initial Selection: For each type of wall covering indicated.

D. Sample Yardage for testing with adhesive, lighting, and installer.

E. Product Schedule: For wall coverings. Use same designations indicated on Drawings.

F. Pre-installation Meeting: Installer to meet with GC and wall covering rep prior to installation to discuss proper installation technique.

1.4 MATERIALS MAINTENANCE SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Wall-Covering Materials: For each type, full-size units equal to 5 percent of amount installed.

1.5 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: As determined by testing identical wall coverings applied with identical adhesives to substrates according to test method indicated below by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Surface-Burning Characteristics: As follows, per ASTM E 84:
   a. Flame-Spread Index: 25 or less.
   b. Smoke-Developed Index: 50 or less.

2. Fire-Growth Contribution: Textile wall coverings tested according to NFPA 265 and complying with test protocol and criteria in the 2003 IBC.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install wall coverings until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Lighting: Do not install wall covering until a permanent level of lighting is provided on the surfaces to receive wall covering.

C. Ventilation: Provide continuous ventilation during installation and for not less than the time recommended by wall-covering manufacturer for full drying or curing.

PART 2 - PRODUCTS

2.1 WALL COVERINGS

A. General: Provide rolls of each type of wall covering from same print run or dye lot.

2.2 VINYL WALL COVERING

A. Vinyl Wall-Covering Standards: Provide mildew-resistant products complying with the following:
   1. CFFA-W-101-D for Type III, Heavy-Duty products.
   2. Products: As scheduled.

2.3 ACCESSORIES

A. Adhesive: Mildew-resistant, nonstaining, strippable adhesive, for use with specific wall covering and substrate application; as recommended in writing by wall-covering manufacturer.

B. Primer/Sealer: Mildew resistant, complying with requirements in Division 09 Section "Interior Painting" and recommended in writing by wall-covering manufacturer for intended substrate.

C. Wall Liner: Nonwoven, synthetic underlayment and adhesive as recommended by wall-covering manufacturer.

D. Seam Tape: As recommended in writing by wall-covering manufacturer.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Installer present, for compliance with requirements for levelness, wall plumbness, maximum moisture content, and other conditions affecting performance of the Work.

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

3.2 PREPARATION

A. Comply with manufacturer's written instructions for surface preparation.

B. Clean substrates of substances that could impair bond of wall covering, including dirt, oil, grease, mold, mildew, and incompatible primers.

C. Prepare substrates to achieve a smooth, dry, clean, structurally sound surface free of flaking, unsound coatings, cracks, and defects.
   1. Moisture Content: Maximum of 5 percent on new plaster, concrete, and concrete masonry units when tested with an electronic moisture meter.
   2. Gypsum Board: Prime with primer as recommended in writing by primer/sealer manufacturer and wall-covering manufacturer.

D. Check painted surfaces for pigment bleeding. Sand gloss, semigloss, and eggshell finish with fine sandpaper.

E. Remove hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

F. Acclimatize wall-covering materials by removing them from packaging in the installation areas not less than 24 hours before installation.

G. Install wall liner, with no gaps or overlaps, where required by wall-covering manufacturer. Form smooth wrinkle-free surface for finished installation. Do not begin wall-covering installation until wall liner has dried.

3.3 INSTALLATION

A. General: Comply with wall-covering manufacturers' written installation instructions applicable to products and applications indicated except where more stringent requirements apply.

B. Cut wall-covering strips in roll number sequence. Change roll numbers at partition breaks and corners.

C. Install strips in same order as cut from roll.

D. Install as recommended by manufacturer.

E. Install wall covering with no gaps or overlaps, no lifted or curling edges, and no visible shrinkage.
F. Match pattern 72 inches (1830 mm) above the finish floor.

G. Install seams vertical and plumb at least 6 inches (150 mm) from outside corners and 6 inches (150 mm) from inside corners unless a change of pattern or color exists at corner. No horizontal seams are permitted.

H. Fully bond wall covering to substrate. Remove air bubbles, wrinkles, blisters, and other defects.

I. Trim edges and seams for color uniformity, pattern match, and tight closure. Butt seams without any overlay or spacing between strips.

3.4 CLEANING

A. Remove excess adhesive at finished seams, perimeter edges, and adjacent surfaces.

B. Use cleaning methods recommended in writing by wall-covering manufacturer.

C. Replace strips that cannot be cleaned.

D. Reinstall hardware and hardware accessories, electrical plates and covers, light fixture trims, and similar items.

END OF SECTION 097200
SECTION 099113 - EXTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes, but is not limited to, surface preparation and the application of paint systems on the following exterior substrates:

1. Concrete, except ceiling.
2. Concrete masonry units (CMU).
3. Wood.

B. Related Requirements:

1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
2. Division 06 Sections for shop priming carpentry with primers specified in this Section.
3. Division 08 Sections for factory priming windows and doors with primers specified in this Section.
4. Division 09 painting Sections for special-use coatings.
5. Division 09 Section "Interior Painting" for surface preparation and the application of paint systems on interior substrates.
6. Division 09 Section "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on exterior wood substrates.
7. Division 09 Section "Hide Performance Coatings" for surface preparation and the application of paint systems on exterior metals.

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

E. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.
1.4 ACTION SUBMITTALS

A. **Product Data:** For each type of product. Include preparation requirements and application instructions.

B. **Samples for Initial Selection:** For each type of topcoat product.

C. **Samples for Verification:** For each type of paint system and each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. **Product List:** For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   2. Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
   3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. **Mockups:** Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
      a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      b. Other Items: Architect will designate items or areas required.
   2. Final approval of color selections will be based on mockups.
      a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
   3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
   4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).
   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
B. Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide products by the Sherwin-Williams Company, or comparable product by one of the following:
   1. Benjamin Moore & Co.
   2. Coronado Paint.
   3. ICI Paints.
   5. PPG Architectural Finishes, Inc.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."
B. Material Compatibility:
   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
C. Colors: As indicated in a color schedule.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:
1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
   1. Concrete: 12 percent.
   3. Wood: 15 percent.
   5. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates and paint systems indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:
   1. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
   2. Sand surfaces that will be exposed to view, and dust off.
   3. Prime edges, ends, faces, undersides, and backsides of wood.
   4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

K. Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and recommendations in "MPI Manual."
   1. Use applicators and techniques suited for paint and substrate indicated.
   2. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
   3. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
   4. Paint entire exposed surface of window frames and sashes.
   5. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
   6. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint undercoats same color as topcoat, but tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Provide sufficient difference in shade of undercoats to distinguish each separate coat.
C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
   1. Paint the following work where exposed to view and do not have factory applied final finishes:
      a. Equipment, including panelboards and switch gear.
      b. Uninsulated metal piping.
      c. Uninsulated plastic piping.
      d. Pipe hangers and supports.
      e. Metal conduit.
      f. Plastic conduit.
      g. Tanks that do not have factory-applied final finishes.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
   2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer’s written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer’s written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 EXTERIOR PAINTING SCHEDULE

A. See Division 09 section “High Performance Coatings” for the following:
   1. Exterior ferrous and non-ferrous metals.
2. Dryfall coatings for exposed steel and concrete ceilings.
3. Floor coatings.
4. For exterior exposed steel or concrete ceilings

B. CONCRETE (Cementitious Siding, Flexboard, Transite Board, Shingles (Non-Roof), Common Brick, Stucco, Tilt-up, Precast, and Poured-in-place Cement)

1. Textured Elastomeric System
   a. Textured Finish
      1) 1st Coat: S-W Loxon Block Surfacer, A24W200 (50-100 sq ft/gal)
      2) 2nd Coat: S-W ConFlex XL Elastomeric High Build Coating, A5-400 Series (16 mils wet, 7.5 mils dry per coat)
      3) 3rd Coat: S-W ConFlex XL Textured Elastomeric High Build Coating, A5-800 (Fine, Medium, Extra Coarse) (20 mils wet, 9.4 mils dry per coat)

2. Stain System
   a. Solid Color Waterborne Finish
      1) 1st Coat: S-W Vertical Concrete Stain, A31 Series
      2) 2nd Coat: S-W Vertical Concrete Stain, A31 Series (50-250 sq/ft gal)

3. Clear Water Repellant
   a. Clear
      1) 1st Coat: S-W Loxon7% Siloxane Water Repellant, A10T7
      2) 2nd Coat: S-W Loxon7% Siloxane Water Repellant, A10T7 (50-200 sq ft/ gal)

C. MASONRY (Concrete Masonry Units (CMU) - Cinder or Concrete Block)

1. Textured Elastomeric System
   a. Textured Finish
      1) 1st Coat: S-W Loxon Block Surfacer, A24W200 (50-100 sq ft/gal)
      2) 2nd Coat: S-W ConFlex XL Elastomeric High Build Coating, A5-400 Series (16 mils wet, 7.5 mils dry per coat)
      3) 3rd Coat: S-W ConFlex XL Textured Elastomeric High Build Coating, A5-800 (Fine, Medium, Extra Coarse) (20 mils wet, 9.4 mils dry per coat)

2. Clear Water Repellant
   a. Clear
      1) 1st Coat: S-W Loxon7% Siloxane Water Repellant, A10T7
      2) 2nd Coat: S-W Loxon7% Siloxane Water Repellant, A10T7 (50-200 sq ft/ gal)

D. WOOD (Siding, Trim, Shutters, Sashes, Hardboard-Bare/Primed)

1. Latex Systems
a. Gloss Finish

1) 1st Coat: S-W A-100 Exterior Latex Wood Primer, B42W41 (4 mils wet, 1.4 mils dry)
2) 2nd Coat: S-W A-100 Exterior Latex Gloss, A8W10051 Series
3) 3rd Coat: S-W A-100 Exterior Latex Gloss, A8W10051 Series (4 mils wet, 1.3 mils dry per coat)

b. Semi-Gloss Finish

1) 1st Coat: S-W A-100 Exterior Latex Wood Primer, B42W41 (4 mils wet, 1.4 mils dry)
2) 2nd Coat: S-W Metalatex Acrylic Semi-Gloss, B42 Series
3) 3rd Coat: S-W Metalatex Acrylic Semi-Gloss, B42 Series (4 mils wet, 1.5 mils dry per coat)

c. Satin Finish

1) 1st Coat: S-W A-100 Exterior Latex Wood Primer, B42W41 (4 mils wet, 1.4 mils dry)
2) 2nd Coat: S-W A-100 Exterior Latex Satin, A82 Series
3) 3rd Coat: S-W A-100 Exterior Latex Satin, A82 Series (4 mils wet, 1.4 mils dry per coat)

E. ARCHITECTURAL PVC, PLASTIC, FIBERGLASS (due to the variety of substrate, check for compatibility)

1. Latex Systems

a. Gloss Finish

1) 1st Coat: S-W PrepRite ProBlock Latex Primer, B51 Series (4 mils wet, 1.4 mils dry)
2) 2nd Coat: S-W A-100 Exterior Latex Gloss, A8W10051 Series
3) 3rd Coat: S-W A-100 Exterior Latex Gloss, A8W10051 Series (4 mils wet, 1.3 mils dry per coat)

b. Semi-Gloss

1) 1st Coat: S-W PrepRite ProBlock Latex Primer, B51 Series (4 mils wet, 1.4 mils dry)
2) 2nd Coat: S-W Metalatex Acrylic Semi-Gloss, B42 Series
3) 3rd Coat: S-W Metalatex Acrylic Semi-Gloss, B42 Series (4 mils wet, 1.5 mils dry per coat)

c. Satin Finish

1) 1st Coat: S-W PrepRite ProBlock Latex Primer, B51 Series (4 mils wet, 1.4 mils dry)
2) 2nd Coat: S-W A-100 Exterior Latex Satin, A82 Series
3) 3rd Coat: S-W A-100 Exterior Latex Satin, A82 Series (4 mils wet, 1.4 mils dry per coat)

F. EXISTING EIFS OR SYNTHETIC STUCCO
1. Latex Systems

a. Semi-Gloss Finish

1) 1st Coat: S-W Metalatex Acrylic Semi-Gloss, B42 Series
2) 2nd Coat: S-W Metalatex Acrylic Semi-Gloss, B42 Series (4 mils wet, 1.5 mils dry per coat)

b. Satin Finish

1) 1st Coat: S-W A-100 Exterior Latex Satin, A82 Series
2) 2nd Coat: S-W A-100 Exterior Latex Satin, A82 Series (4 mils wet, 1.4 mils dry per coat)

END OF SECTION 099113
SECTION 099123 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes, but is not limited to, surface preparation and the application of paint systems on the following interior substrates:

1. Concrete, except ceilings.
2. Concrete masonry units (CMU).
3. Steel.
5. Aluminum (not anodized or otherwise coated).
6. Wood.
7. Gypsum board.

B. Related Requirements:

1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
2. Division 06 Sections for shop priming carpentry with primers specified in this Section.
3. Division 08 Sections for factory priming windows and doors with primers specified in this Section.
4. Division 09 painting Sections for high-performance and special-use coatings.
5. Division 09 Section "Exterior Painting" for surface preparation and the application of paint systems on exterior substrates.
6. Division 09 Section "Staining and Transparent Finishing" for surface preparation and the application of wood stains and transparent finishes on interior wood substrates.
7. Division 09 Section "High Performance Coatings" for concrete ceilings and floors, wood flooring and specialty CMU coatings.

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.
E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of topcoat product.

C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
   1. Submit Samples on rigid backing, 8 inches (200 mm) square.
   2. Step coats on Samples to show each coat required for system.
   3. Label each coat of each Sample.
   4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:
   1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
   2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
   3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Paint: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
      a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
      b. Other Items: Architect will designate items or areas required.
   2. Final approval of color selections will be based on mockups.
      a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

   1. Maintain containers in clean condition, free of foreign materials and residue.
   2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide products by The Sherwin-Williams Company, or comparable product by one of the following:

   1. Benjamin Moore & Co.
   2. Coronado Paint.
   3. ICI Paints.
   5. PPG Architectural Finishes, Inc.

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

   1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Dry-Fog Coatings: 400 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.
5. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
7. Pretreatment Wash Primers: 420 g/L.
8. Floor Coatings: 100 g/L.
9. Shellacs, Clear: 730 g/L.
10. Shellacs, Pigmented: 550 g/L.

D. Low-Emitting Materials: Interior paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Colors: As indicated in a color schedule.

2.3 SOURCE QUALITY CONTROL

A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample paint materials. Contractor will be notified in advance and may be present when samples are taken. If paint materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

2. Testing agency will perform tests for compliance with product requirements.

3. Owner may direct Contractor to stop applying coatings if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.
5. Plaster: 12 percent.
C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.
   1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
   1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer’s written instructions.

E. Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceed that permitted in manufacturer’s written instructions.

F. Steel Substrates: Remove rust, loose mill scale, and shop primer, if any. Clean using methods recommended in writing by paint manufacturer.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:
   1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
   2. Sand surfaces that will be exposed to view, and dust off.
   3. Prime edges, ends, faces, undersides, and backsides of wood.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

1. Use applicators and techniques suited for paint and substrate indicated.
2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.

D. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:
   a. Equipment, including panelboards and switch gear that does not have factory applied final finish.
   b. Tanks that do not have factory-applied final finishes.

2. Paint the following work where exposed in occupied spaces:
   a. Equipment, including panelboards. (Verify all equipment to be painted with Architect before painting)
   b. Uninsulated metal piping.
   c. Uninsulated plastic piping.
   d. Pipe hangers and supports.
   e. Metal conduit.
   f. Plastic conduit.
   g. Duct, equipment, and pipe insulation having paintable jacket material.
   h. Other items as directed by Architect.

3. Paint portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets that are visible from occupied spaces.
3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
   1. Contractor shall touch up and restore painted surfaces damaged by testing.
   2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
C. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.
D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.6 INTERIOR PAINTING SCHEDULE

A. See Division 9 section “High Performance Coatings” for the following:
   1. Dryfall coatings for ceilings other than drywall or plaster.
   2. Floor coatings.
B. CONCRETE - (Walls & Ceilings, Poured Concrete, Precast Concrete, Unglazed Brick, Cement Board, Tilt-Up, Cast-In-Place)
   1. Latex Systems
      a. Eg-Shel / Satin Finish
         1) 1st Coat: S-W PrepRite® Masonry Primer, B28W300 (7 mils wet, 3 mils dry)
         2) 2nd Coat: S-W ProMar® 200 Latex Eg-Shel Enamel, B20W2200 Series
         3) 3rd Coat: S-W ProMar® 200 Latex Eg-Shel Enamel, B20W2200 Series (4 mils wet, 1.3 mils dry per coat)
C. MASONRY - (CMU - Concrete, Split, Scored, Smooth, Fluted)
   1. Latex Systems
      a. Eg-Shel / Satin Finish
         1) 1st Coat: S-W PrepRite® Block Filler, B25W25 (75-125 sq ft/gal)
         2) 2nd Coat: S-W ProMar® 200 Latex Eg-Shel Enamel, B20W2200 Series
3) 3rd Coat: S-W ProMar® 200 Latex Eg-Shel, B20W2200 Series (4 mils wet, 1.6 mils dry per coat)

D. METAL - (Aluminum, Galvanized)

1. Alkyd Systems
   a. Gloss Finish (Water base)
      1) 1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series (2.0 - 4.0 mils dry per coat)
      2) 2nd Coat: S-W Waterbased Industrial Enamel, B53-300 Series
      3) 3rd Coat: S-W Waterbased Industrial Enamel, B53-300 Series (4 mils wet, 1.6 mils dry per coat)
   b. Semi-Gloss (solvent base) Finish
      1) 1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series (2-4 mils dry)
      2) 2nd Coat: S-W ProMar® 200 Alkyd Semi-Gloss, B34W200 Series
      3) 3rd Coat: S-W ProMar® 200 Alkyd Semi-Gloss, B34W200 Series (4 mils wet, 1.7 mils dry per coat)

E. METAL -Steel (Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous & Ornamental Iron, Structural Iron, Ferrous Metal)

1. Alkyd Systems
   a. a. Gloss Finish (Solvent Base)
      1) 1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series (2-4 mils dry)
      2) 2nd Coat: S-W Industrial Enamel HS, B54Z400 Series
      3) 3rd Coat: S-W Industrial Enamel HS, B54Z400 Series (2.0 - 4.0 mils dry per coat)
   b. Gloss Finish (Water Base)
      1) 1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series (2-4 mils dry)
      2) 2nd Coat: S-W Sher-Cryl™ HPA Acrylic, B66-300 Series
      3) 3rd Coat: S-W Sher-Cryl™ HPA Acrylic, B66-300 Series (4 mils wet, 1.6 mils dry per coat)
   c. Semi-Gloss (Solvent base)
      1) 1st Coat: S-W Pro Industrial Pro-Cryl® Primer, B66-310 Series (2-4 mils dry)
      2) 2nd Coat: S-W ProMar® 200 Alkyd Semi-Gloss, B34W200 Series
      3) 3rd Coat: S-W ProMar® 200 Alkyd Semi-Gloss, B34W200 Series (4 mils wet, 1.7 mils dry per coat)

F. WOOD- (Walls, Ceilings, Doors, Trim,)
1. Alkyd Systems
   a. Gloss Finish (Water base)
      1) 1st Coat: S-W PrepRite® Classic Primer, B28W101 (4 mils wet, 1.6 mils dry)
      2) 2nd Coat: S-W Waterbased Industrial Enamel, B53-300 Series
      3) 3rd Coat: S-W Waterbased Industrial Enamel, B53-300 Series (4 mils wet, 1.6 mils dry per coat)
   b. Semi-Gloss (Solvent base) Finish
      1) 1st Coat: S-W PrepRite® Wall & Wood Oil Primer/Undercoater, (4 mils wet, 2 mils dry)
      2) 2nd Coat: S-W ProMar® 200 Alkyd Semi-Gloss, B34W200 Series
      3) 3rd Coat: S-W ProMar® 200 Alkyd Semi-Gloss, B34W200 Series (4 mils wet, 1.7 mils dry per coat)

2. Stain & Varnish
   a. Clear Finish
      1) 1st Coat: S-W Wood Classics® Interior Oil Stain, A49 Series (Optional)
      2) 2nd Coat: S-W Wood Classics® FastDry Sanding Sealer, B26V43
      3) 3rd Coat: S-W Wood Classics® FastDry Varnish, Gloss or Satin, A66 Series (4 mils wet, 1.3 mils dry per coat)

G. DRYWALL (Walls, Ceilings, Gypsum Board, Plaster Board, etc.)

1. Latex Systems
   a. Eg-Shel / Satin Finish
      1) 1st Coat: S-W PrepRite® 200 Latex Primer, B28W200 (4 mils wet, 1.2 mils dry)
      2) 2nd Coat: S-W ProMar® 200 Latex Eg-Shel, B20W2200 Series
      3) 3rd Coat: S-W ProMar® 200 Latex Eg-Shel, B20W2200 Series (4 mils wet, 1.6 mils dry per coat)

END OF SECTION 099123
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes surface preparation and application of wood finishes on the following substrates:

1. Interior Substrates:
   a. Dressed lumber (finish carpentry).
   b. Exposed wood panel products.

B. Related Requirements:
   1. Division 09 Section "Interior Painting" for stains and transparent finishes on concrete floors.

1.3 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

D. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

E. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.

B. Samples for Initial Selection: For each type of product indicated.

C. Samples for Verification: For each type of finish system and in each color and gloss of finish indicated.

1. Submit Samples on representative samples of actual wood substrates, 8 inches (200 mm) square or 8 inches (200 mm) long.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.
D. Product List: For each product indicated, include the following:

1. Cross-reference to finish system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the product proposed for use highlighted.
3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Stains and Transparent Finishes: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each finish system indicated and each color selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each type of finish system and substrate.
   a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
   b. Other Items: Architect will designate items or areas required.

2. Final approval of stain color selections will be based on mockups.
   a. If preliminary stain color selections are not approved, apply additional mockups of additional stain colors selected by Architect at no added cost to Owner.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.8 FIELD CONDITIONS

A. Apply finishes only when temperature of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply finishes when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Do not apply exterior finishes in snow, rain, fog, or mist.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Subject to compliance with requirements, provide products by The Sherwin-Williams Company, or comparable product by one of the following:

1. Benjamin Moore & Co.
2. Coronado Paint.
3. ICI Paints.
5. PPG Architectural Finishes, Inc.
6. Pratt & Lambert

2.2 MATERIALS, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each finish system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a finish system, provide products recommended in writing by manufacturers of topcoat for use in finish system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior stains and finishes applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Clear Wood Finishes, Varnishes: VOC not more than 350 g/L.
2. Shellacs, Clear: VOC not more than 730 g/L.
3. Stains: VOC not more than 250 g/L.
4. Primers, Sealers, and Undercoaters: 200 g/L.

D. Low-Emitting Materials: Interior stains and finishes shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. Stain Colors: As approved by Architect from samples.

2.3 SOURCE QUALITY CONTROL

A. Testing of Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample wood finishing materials. Contractor will be notified in advance and may be present when samples are taken. If materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. Owner may direct Contractor to stop applying wood finishes if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying materials from Project site, pay for testing, and refinish surfaces finished with rejected materials. Contractor will be required to remove rejected materials from previously finished surfaces before refinishing with complying materials if the two finishes are incompatible or produce results that, in the opinion of the Architect, are aesthetically unacceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Exterior Wood Substrates: 15 percent, when measured with an electronic moisture meter.

C. Maximum Moisture Content of Interior Wood Substrates: 10 percent, when measured with an electronic moisture meter.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with finish application only after unsatisfactory conditions have been corrected.

1. Beginning finish application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and finishing.

1. After completing finishing operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean and prepare surfaces to be finished according to manufacturer's written instructions for each particular substrate condition and as specified.

1. Remove dust, dirt, oil, and grease by washing with a detergent solution; rinse thoroughly with clean water and allow to dry. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
2. Remove mildew by scrubbing with a commercial wash formulated for mildew removal and as recommended by stain manufacturer.

D. Interior Wood Substrates:
1. Scrape and clean knots, and apply coat of knot sealer before applying primer.
2. Apply wood filler paste to open-grain woods, as defined in "MPI Architectural Painting Specification Manual," to produce smooth, glasslike finish.
3. Sand surfaces that will be exposed to view and dust off.
4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply finishes according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
   1. Use applicators and techniques suited for finish and substrate indicated.
   2. Finish surfaces behind movable equipment and furniture same as similar exposed surfaces.
   3. Do not apply finishes over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Apply finishes to produce surface films without cloudiness, holidays, lap marks, brush marks, runs, ropiness, or other surface imperfections.

3.4 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing finish application, clean spattered surfaces. Remove spattered materials by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from finish application. Correct damage by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced finished wood surfaces.

3.5 EXTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. See Division 09 section "High Performance Coatings" for the following:
   1. Floor coatings.

B. Opaque
   1. Alkyd System
      a. Solid Color Alkyd Stain
         1) 1st Coat: S-W Solid Color Alkyd Stain, A14-500 Series
         2) 2nd Coat: S-W Solid Color Alkyd Stain, A14-500 Series (200-300 sq ft/gal)

C. Transparent / Semi Transparent
1. Waterborne Alkyd System
   a. Transparent Finish
      1) 1st Coat: S-W DeckScapes Ext. Waterborne Clear, A15T260
      2) 2nd Coat: S-W DeckScapes Ext. Waterborne Clear, A15T260 (150-300 sq ft/gal)
   b. Semi-Transparent Finish
      1) 1st Coat: S-W DeckScapes Ext. Waterborne Toner, A15T452
      2) 2nd Coat: S-W DeckScapes Ext. Waterborne Toner, A15T452 (150-300 sq ft/gal)

3.6 INTERIOR WOOD-FINISH-SYSTEM SCHEDULE

A. See Division 09 section “High Performance Coatings” for the following:

1. Floor coatings.

B. Transparent

1. Lacquer (topcoat)
   a. Transparent Finish
      1) 1st Coat: S-W Sher-Wood Hi-Bild Lacquer Sanding Sealer
      2) 2nd Coat: S-W SHER-WOOD® CAB-Acrylic Lacquer
      3) 3rd Coat: S-W SHER-WOOD® CAB-Acrylic Lacquer

2. Polyurethane System (topcoat)
   a. Transparent Finish
      1) 1st Coat: S-W WoodClassics Polyurethane Varnish, A67 Series
      2) 2nd Coat: S-W WoodClassics Polyurethane Varnish, A67 Series (350-400 sq ft/gal)

C. Semi-Transparent

1. Lacquer (topcoat)
   a. Semi-Transparent Stain
      1) 1st Coat: S-W WoodClassics Oil Stain, A49 Series (450-500 sq ft/gal)
      2) 2nd Coat: S-W Sher-Wood Hi-Bild Lacquer Sanding Sealer
      3) 3rd Coat: S-W SHER-WOOD® CAB-Acrylic Lacquer
      4) 4th Coat: S-W SHER-WOOD® CAB-Acrylic Lacquer

2. Polyurethane (topcoat)
   a. Semi-Transparent Stain
      1) 1st Coat: S-W WoodClassics Oil Stain, A49 Series (450-500 sq ft/gal)
      2) 2nd Coat: S-W WoodClassics Polyurethane Varnish, A67 Series
3) 3rd Coat: S-W WoodClassics Polyurethane Varnish, A67 Series (350-400 sq ft/gal)

END OF SECTION 099300
SECTION 099600 - HIGH-PERFORMANCE COATINGS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes surface preparation and application of high-performance coating systems on the following substrates:
      1. Exterior Substrates:
         a. Concrete, ceiling surfaces.
         b. Steel.
         c. Galvanized metal.
         d. Aluminum (not anodized or otherwise coated).
         e. Glass-Mat Gypsum Sheathing (Soffits)
      2. Interior Substrates:
         a. Concrete, ceiling surfaces.
         b. Concrete flooring
         c. Concrete masonry units (CMU).
   B. Related Requirements:
      1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
      2. Division 09 painting Sections for special-use coatings and general field painting.

1.3 DEFINITIONS
   A. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.
   B. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.4 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include preparation requirements and application instructions.
   B. Samples for Initial Selection: For each type of topcoat product indicated.
   C. Samples for Verification: For each type of coating system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches (200 mm) square.
2. Step coats on Samples to show each coat required for system.
3. Label each coat of each Sample.
4. Label each Sample for location and application area.

D. Product List: For each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.
3. VOC content.

1.5 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings: 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

1.6 QUALITY ASSURANCE

A. Mockups: Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each coating system specified in Part 3.

   a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
   b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

   a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F (7 deg C).

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.
1.8 FIELD CONDITIONS

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 50 and 95 deg F (10 and 35 deg C).

B. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

C. Do not apply exterior coatings in snow, rain, fog, or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products shown in high-performance coating schedule by The Sherwin-Williams Company and Tnemec, or comparable product by one of the following:

1. Benjamin Moore & Co.
2. Coronado Paint.
3. ICI Paints.
5. PPG Architectural Finishes, Inc.
7. Tnemec, Inc.

2.2 HIGH-PERFORMANCE COATINGS, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and are listed in "MPI Approved Products List."

B. Material Compatibility:
   1. Provide materials for use within each coating system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
   2. For each coat in a coating system, provide products recommended in writing by manufacturers of topcoat for use in coating system and on substrate indicated.
   3. Provide products of same manufacturer for each coat in a coating system.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior coatings applied at project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 150 g/L.
3. Primers, Sealers, and Undercoaters: 200 g/L.
4. Anti-Corrosive and Anti-Rust Paints Applied to Ferrous Metals: 250 g/L.
6. Pre-Treatment Wash Primers: 420 g/L.
7. Floor Coatings: 100 g/L.
8. Shellacs, Clear: 730 g/L.
9. Shellacs, Pigmented: 550 g/L.

D. Colors: As indicated in finish legend/schedule.

2.3 SOURCE QUALITY CONTROL

A. Testing of Coating Materials: Owner reserves the right to invoke the following procedure:

1. Owner will engage the services of a qualified testing agency to sample coating materials. Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed, and certified by testing agency.

2. Testing agency will perform tests for compliance with product requirements.

3. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying coating materials from Project site, pay for testing, and recoat surfaces coated with rejected materials. Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two coatings are incompatible.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

   a. Concrete: 12 percent.
   b. Masonry (Clay and CMU): 12 percent.
   c. Wood: 15 percent.
   d. Gypsum Board: 12 percent.

B. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

C. Proceed with coating application only after unsatisfactory conditions have been corrected.

   1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

C. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
   1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces to be coated exceeds that permitted in manufacturer's written instructions.
   1. Clean surfaces with pressurized water. Use pressure range of 1500 to 4000 psi (10 350 to 27 580 kPa) at 6 to 12 inches (150 to 300 mm).

E. Masonry Substrates: Remove efflorescence and chalk. Do not coat surfaces if moisture content or alkalinity of surfaces or if alkalinity of mortar joints exceed that permitted in manufacturer's written instructions.
   1. Clean surfaces with pressurized water. Use pressure range of 100 to 600 psi (690 to 4140 kPa) at 6 to 12 inches (150 to 300 mm).

F. Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.

G. Shop-Primed Steel Substrates: Clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.

H. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied coatings.

I. Aluminum Substrates: Remove loose surface oxidation.

J. Wood Substrates:
   1. Scrape and clean knots. Before applying primer apply coat of knot sealer recommended in writing by topcoat manufacturer for coating system indicated.
   2. Sand surfaces that will be exposed to view and dust off.
   3. Prime edges, ends, faces, undersides, and back sides of wood.
   4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.

3.3 APPLICATION

A. Apply high-performance coatings according to manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."
   1. Use applicators and techniques suited for coating and substrate indicated.
   2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of the same material are to be applied. Tint undercoats to match color of finish coat, but provide sufficient difference in shade of undercoats to distinguish each separate coat.

C. If undercoats or other conditions show through final coat, apply additional coats until cured film has a uniform coating finish, color, and appearance.

D. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections. Produce sharp glass lines and color breaks.

3.4 FIELD QUALITY CONTROL

A. Dry Film Thickness Testing: Owner will engage the services of a qualified testing and inspecting agency to inspect and test coatings for dry film thickness.

1. Contractor shall touch up and restore coated surfaces damaged by testing.
2. If test results show that dry film thickness of applied coating does not comply with coating manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with coating manufacturer's written recommendations.

3.5 CLEANING AND PROTECTION

A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.

B. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.

C. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by Architect, and leave in an undamaged condition.

D. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.6 HIGH-PERFORMANCE COATING SCHEDULE

A. TEXTURED ACRYLIC COATING FOR EXTERIOR GYP SHEATHING:

1. Acrylic-Based Finish Coatings: Factory-mixed acrylic-emulsion coating systems, formulated with colorfast mineral pigments and fine aggregates for texture. Include manufacturer's recommended base coat, reinforcing mesh and sealing topcoats for acrylic-based finishes.

2. Products:
b. TEIFS; Ekote

3. Color: Textures and color to be selected by Architect from manufacturer's full range.
4. Locations: Soffits and/or as indicated on drawings.

B. CONCRETE (Ceilings)

1. Dryfall Waterborne Systems
   a. Eg-Shel Finish
      1) 1st Coat:
         a) Interior: S-W Waterborne Acrylic Dryfall, B42W2
         b) Exterior: S-W Pro-Cryl® Universal Acrylic Primer, B66-310
      2) 2nd Coat: S-W Waterborne Acrylic Dryfall, B42W2 (11 mils wet, 4.5 mils dry per coat)
   b. Flat Finish
      1) 1st Coat:
         a) Interior: S-W Waterborne Acrylic Dryfall, B42W1
         b) Exterior: S-W Pro-Cryl® Universal Acrylic Primer, B66-310
      2) 2nd Coat: S-W Waterborne Acrylic Dryfall, B42W1 (11 mils wet, 4.5 mils dry per coat)

C. Non-Ferrous- (Galvanized & Aluminum)

1. Fluoropolymer System
   a. Surface Preparation: Mechanically abrade all surfaces as per ASTM D 6386. Consult Tnemec for optional methods. Prepare all bare metal and damaged galvanized as per SSPC-SP6 Commercial Blast Cleaning or SSPC-SP11 Power Tool Cleaning to Bare Metal obtaining a minimum 1.5 mil anchor profile, angular, not peened. Spot prime prepared bare metal using Tnemec Series 1 Omnithane applied at 2.5 to 3.5 dry mils.
   b. First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 3.0 to 5.0 dry mils.
   c. Second Coat: Tnemec Series
      1) Flat: 1070 Fluoronar applied at 2.0 to 3.0 dry mils.
      2) Semi-gloss: 1071 Fluoronar applied at 2.0 to 3.0 dry mils.
      3) Satin: 1072 Fluoronar applied at 2.0 to 3.0 dry mils.

2. Dryfall Waterborne Systems (Ceilings)
   a. Eg-Shel Finish
      1) 1st Coat:
         a) Interior: S-W Waterborne Acrylic Dryfall, B42W2
b) Exterior: Shop Prime is acceptable, use S-W Pro-Cryl® Universal Acrylic Primer, B66-310 for field touch ups.

2) 2nd Coat: S-W Waterborne Acrylic Dryfall, B42W2 (7 mils wet, 3 mils dry per coat)

b. Flat Finish
c. 1st Coat:

a) Interior: S-W Waterborne Acrylic Dryfall, B42W1
b) Exterior: Shop Prime is acceptable, use S-W Pro-Cryl® Universal Acrylic Primer, B66-310 for field touch ups.

2) 2nd Coat: S-W Waterborne Acrylic Dryfall, B42W1 (7 mils wet, 3 mils dry per coat)

D. METAL - (Structural Steel Columns, Joists, Trusses, Beams, Miscellaneous & Ornamental Iron, Structural Iron, Ferrous Metal)

1. Structural & Miscellaneous Steel

a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
b. Prime Coat: Tnemec Series 90-97 Tneme-Zinc applied at 2.5 to 3.5 dry mils.
c. First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 3.0 to 5.0 dry mils.
d. Second Coat: Tnemec Series

1) Flat: 1070 Fluoronar applied at 2.0 to 3.0 dry mils.
2) Semi-gloss: 1071 Fluoronar applied at 2.0 to 3.0 dry mils.
3) Satin: 1072 Fluoronar applied at 2.0 to 3.0 dry mils.

2. Handrails, Doors:

a. Surface Preparation: SSPC-SP6 Commercial Blast Cleaning.
b. Prime Coat: Tnemec Series 90-97 Tneme-Zinc applied at 2.5 to 3.5 dry mils.
c. First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 3.0 to dry mils.
d. Second Coat: Tnemec Series 290 CRU applied at 1.5 to 2.5 dry mils.

3. Galvanized Metal:

a. Surface Preparation: Mechanically abrade all surfaces as per ASTM D 6386. Consult Tnemec for optional methods. Prepare all bare metal and damaged galvanized as per SSPC-SP6 Commercial Blast Cleaning or SSPC-SP11 Power Tool Cleaning to Bare Metal obtaining a minimum 1.5 mil anchor profile, angular, not peened. Spot prime prepared bare metal using Tnemec Series 1 Omnithane applied at 2.5 to 3.5 dry mils.
b. First Coat: Tnemec Series N69 Hi-Build Epoxoline II applied at 3.0 to 5.0 dry mils.
c. Second Coat: Tnemec Series

1) Flat: 1070 Fluoronar applied at 2.0 to 3.0 dry mils.
2) Semi-gloss: 1071 Fluoronar applied at 2.0 to 3.0 dry mils.
3) Satin: 1072 Fluoronar applied at 2.0 to 3.0 dry mils.

E. METAL - (Ceilings - Structural Steel, Joists, Trusses, Beams)

1. Dryfall Waterborne Topcoats
a. Eg-Shel Finish

1) 1st Coat: S-W DTM Acrylic Primer/Finish, B66W1 (2.5-4 mils dry per coat)
2) 2nd Coat: S-W DTM Acrylic Primer/Finish, B66W1 (2.5-4 mils dry per coat)

b. Flat Finish

1) 1st Coat: S-W DTM Acrylic Primer/Finish, B66W1 (2.5-4 mils dry per coat)
2) 2nd Coat: S-W DTM Acrylic Primer/Finish, B66W1 (2.5-4 mils dry per coat)

F. CMU (Walls)

1. Epoxy / Urethane Wall Coating

a. Transparent Finish

1) 1st Coat: Tnemec Series 287 Enviro-Pox applied at 2.0 to 3.0 dry mils.
2) 2nd Coat: Tnemec Series 287 Enviro-Pox applied at 2.0 to 3.0 dry mils.
3) 3rd Coat: Tnemec Series 296 Enviro-Tread UR Clear applied at 2.0-3.0 dry mils.

2. Shower Wall Coating - Fiberglass Mat Reinforced Epoxy

a. Opaque Finish

1) 1st Coat: Tnemec Series 215 Surfacing Epoxy trowel applied at 1/32” (Surfacem/Bonding Coat)
2) Fiberglass Reinforcement: Tnemec 273-0273C Fiberglass mat. Overlap and double cut seams.
3) 2nd Coat: Tnemec Series 273 Stranlok ML applied at 6.0-8.0 dry mils. Following saturant coat cure, sand the surfaces to remove any raised fiber and or excess material (Saturant Coat).
4) 3rd Coat: Tnemec Series 280 Tneme-Glaze applied at 6.0-8.0 dry mils (Glaze Coat).
5) 4rth coat: Tnemec 290 CRU applied at 2.0-3.0 dry mils (Finish Coat).

3.7 HIGH PERFORMANCE FLOOR COATINGS SCHEDULE

A. Light Industrial Duty: (Is Generally Considered For Industrial Foot Traffic & handcarts)

1. Colored Acrylic Primer / Acrylic System

a. 1st Coat: ArmorSeal® Tread-Plex™ Primer, B90W110 (1.5 - 2.0 mils dry)
b. 2nd Coat: ArmorSeal® Tread-Plex™, B90 Series (1.5 - 2.0 mils dry per coat)
c. 3rd Coat: ArmorSeal® Tread-Plex™, B90 Series (1.5 - 2.0 mils dry per coat) (optional)

2. Colored Epoxy System

a. 1st Coat: ArmorSeal® 1000 HS Epoxy, B67-2000 Series (3.0 - 5.0 dry mils)
b. 2nd Coat: ArmorSeal® 1000 HS Epoxy, B67-2000 Series (3.0 - 5.0 dry mils)
c. 3rd Coat: ArmorSeal® 1000 HS Epoxy, B67-2000 Series (3.0 - 5.0 dry mils)

3. Clear Waterborne Epoxy-Amine
a. 1st Coat: Tnemec Series 287 Enviro-Pox (2.0 - 4.0 dry mils).
b. 2nd Coat: Tnemec Series 287 Enviro-Pox (2.0 - 4.0 dry mils).

END OF SECTION 099600
SECTION 102113 - TOILET COMPARTMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Solid-polymer toilet compartments configured as toilet enclosures and urinal screens.

B. Related Sections:
   1. Division 06 Section "Miscellaneous Rough Carpentry" for blocking.
   2. Division 10 Section "Toilet, Bath, and Laundry Accessories" for toilet tissue dispensers, grab bars, purse shelves, and similar accessories.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For toilet compartments. Include plans, elevations, sections, details, and attachments to other work.
   1. Show locations of cutouts for compartment-mounted toilet accessories.
   2. Show locations of reinforcements for compartment-mounted grab bars.
   3. Show locations of centerlines of toilet fixtures.
   4. Show ceiling grid and overhead support or bracing locations.

C. Samples for Initial Selection: For each type of unit indicated. Include Samples of hardware and accessories involving material and color selection.

1.4 QUALITY ASSURANCE


B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 or NFPA 286, or another standard acceptable to authorities having jurisdiction, by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

C. Regulatory Requirements: Comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines for Buildings and Facilities" and Texas Accessibility Standards (TAS) for toilet compartments designated as accessible.
1.5 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of toilet fixtures, walls, columns, ceilings, and other construction contiguous with toilet compartments by field measurements before fabrication.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aluminum Castings: ASTM B 26/B 26M.
B. Aluminum Extrusions: ASTM B 221 (ASTM B 221M).
C. Brass Castings: ASTM B 584.
D. Brass Extrusions: ASTM B 455.
E. Steel Sheet: Commercial steel sheet for exposed applications; mill phosphatized and selected for smoothness.
   1. Electrolytically Zinc Coated: ASTM A 879/A 879M, 01Z (03G).
F. Stainless-Steel Sheet: ASTM A 666, Type 304, stretcher-leveled standard of flatness.
G. Stainless-Steel Castings: ASTM A 743/A 743M.
H. Zamac: ASTM B 86, commercial zinc-alloy die castings.
I. Particleboard: ANSI A208.1, Grade M-2 with 45-lb (20.4-kg) density[.]
J. Plastic Laminate: NEMA LD 3, general-purpose HGS grade, 0.048-inch (1.2-mm) nominal thickness.

2.2 SOLID-POLYMER UNITS

A. Manufacturers:
B. Toilet-Enclosure Style: Floor Mounted Headrail Braced.
C. Urinal-Screen Style: Wall hung.
D. Door, Panel, Screen, and Pilaster Construction: Solid, high-density polyethylene (HDPE) or polypropylene (PP) panel material, not less than 1 inch (25 mm) thick, seamless, with eased edges, and with homogenous color and pattern throughout thickness of material.
   1. Integral Hinges: Configure doors and pilasters to receive Stealth Integral hinges.
   2. Color and Pattern:
      a. Color: Shale
      b. Pattern: Orange Peel
E. Fire Hazard Classification: Not required.

F. Pilaster Shoes and Sleeves (Caps): Stainless steel.

G. Urinal-Screen Post: Manufacturer's standard post design of material matching the thickness and construction of pilasters; with shoe and sleeve (cap) matching that on the pilaster.

H. Brackets (Fittings):
   1. Full-Height (Continuous) Type: Stainless steel.

I. Overhead Cross Bracing for Ceiling-Hung Units: As recommended by manufacturer and fabricated from Stainless Steel.

2.3 ACCESSORIES

A. Hardware and Accessories: Manufacturer's standard design, heavy-duty operating hardware and accessories.
   1. Material: Manufacturer's standard stainless steel.
   2. Hinges: Manufacturer's standard continuous, cam type that swings to a closed or partially open position or integral hinge for solid-polymer doors.
   3. Latch and Keeper: Manufacturer's standard latch unit designed for emergency access and with combination rubber-faced door strike and keeper. Provide units that comply with regulatory requirements for accessibility at compartments designated as accessible.
   4. Coat Hook: Manufacturer's standard combination hook and rubber-tipped bumper, sized to prevent in-swinging door from hitting compartment-mounted accessories.
   5. Door Bumper: Manufacturer's standard rubber-tipped bumper at out-swinging doors.
   6. Door Pull: Manufacturer's standard unit at out-swinging doors that complies with regulatory requirements for accessibility. Provide units on both sides of doors at compartments designated as accessible.

B. Anchorages and Fasteners: Manufacturer's standard exposed fasteners of stainless steel or chrome-plated steel or brass, finished to match the items they are securing, with theft-resistant-type heads. Provide sex-type bolts for through-bolt applications. For concealed anchors, use stainless steel, hot-dip galvanized steel, or other rust-resistant, protective-coated steel.

2.4 FABRICATION

A. Overhead-Braced Units: Provide manufacturer's standard corrosion-resistant supports, leveling mechanism, and anchors at pilasters to suit floor conditions. Provide shoes at pilasters to conceal supports and leveling mechanism.

B. Urinal-Screen Posts: Provide manufacturer's standard corrosion-resistant anchoring assemblies with leveling adjustment at bottoms of posts. Provide shoes and sleeves (caps) at posts to conceal anchorage.

C. Door Size and Swings: Unless otherwise indicated, provide 24-inch- (610-mm-) wide, in-swinging doors for standard toilet compartments and 36-inch- (914-mm-) wide, out-swinging doors with a minimum 32-inch- (813-mm-) wide, clear opening for compartments designated as accessible.

PART 3 - EXECUTION
3.1 INSTALLATION

A. General: Comply with manufacturer's written installation instructions. Install units rigid, straight, level, and plumb. Secure units in position with manufacturer's recommended anchoring devices.

1. Maximum Clearances:
   a. Pilasters and Panels: 1/2 inch (13 mm).
   b. Panels and Walls: 1 inch (25 mm).

B. Overhead-Braced Units: Secure pilasters to floor and level, plumb, and tighten. Set pilasters with anchors penetrating not less than 1-3/4 inches (44 mm) into structural floor unless otherwise indicated in manufacturer's written instructions. Secure continuous head rail to each pilaster with no fewer than two fasteners. Hang doors to align tops of doors with tops of panels, and adjust so tops of doors are parallel with overhead brace when doors are in closed position.

C. Ceiling-Hung Units: Secure pilasters to supporting structure and level, plumb, and tighten. Hang doors and adjust so bottoms of doors are level with bottoms of pilasters when doors are in closed position.

D. Urinal Screens: Attach with anchoring devices to suit supporting structure. Set units level and plumb, rigid, and secured to resist lateral impact.

3.2 ADJUSTING

A. Hardware Adjustment: Adjust and lubricate hardware according to hardware manufacturer's written instructions for proper operation. Set hinges on in-swinging doors to hold doors open approximately 30 degrees from closed position when unlatched. Set hinges on out-swinging doors to return doors to fully closed position.

END OF SECTION 102113
SECTION 102310 - GLAZED INTERIOR WALL AND DOOR ASSEMBLIES

PART 1 - GENERAL
1.1 SECTION INCLUDES
   A. Frameless glazed interior wall and door assemblies.

1.2 RELATED REQUIREMENTS
   A. Section 088000 "Glazing"

1.3 REFERENCE STANDARDS

1.4 ADMINISTRATIVE REQUIREMENTS
   A. Pre-installation Meeting: Convene at project site seven calendar days prior to scheduled beginning of construction activities of this section to review section requirements.
      1. Require attendance by representatives of installer, other entities directly affecting, or affected by, construction activities of this section.
      2. Notify Architect four calendar days in advance of scheduled meeting date.

1.5 SUBMITTALS
   A. See Section 013300 - Submittal Procedures.
   B. Product Data: Manufacturer's descriptive literature for each component in partition assembly.
   C. Shop Drawings: Drawings showing layout, dimensions, identification of components, and interface with adjacent construction.
      1. Include field measurements of openings.
      2. Include Elevations Showing:
         a. Locations and identification of manufacturer-supplied door hardware and fittings.
         b. Locations and sizes of cut-outs and drilled holes for other door hardware.
      3. Include Details Showing:
         a. Requirements for support and bracing of overhead track.
         b. Installation details.
         c. Appearance of manufacturer-supplied door hardware and fittings.
   D. Selection Samples: Two sets, representing manufacturer's full range of available metal materials and finishes.
   E. Verification Samples: Two samples, minimum size 2 by 3 inches (50 by 75 mm), representing actual material and finish of exposed metal.
   F. Design Data: Design calculations, bearing seal and signature of structural engineer licensed to practice in the State in which the Project is located, showing loads at points of attachment to the building structure.
G. Certificates: Contractor to certify that installer of partition assemblies meets specified qualifications.

H. Operation and Maintenance Data: For manufacturer-supplied operating hardware.

I. Warranty Documentation: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

J. Specimen Warranty.

K. Manufacturer's Installation Instructions: Include complete preparation, installation, and cleaning requirements.

1.6 QUALITY ASSURANCE

A. Fabricator Qualifications: Minimum three years of experience designing, assembling, and installing partition assemblies similar to those specified in this section.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until installation.

1.8 WARRANTY

A. See Section 017700 - Closeout Procedures, for additional warranty requirements.

B. Correct defective Work within a one year period after date of Substantial Completion.

C. Provide five year manufacturer warranty against excessive degradation of metal finishes. Include provision for replacement of units with excessive fading, chalking, or flaking.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Frameless Glazed Interior Wall and Door Assemblies:
   2. Substitutions: See Section 012100 - Substitution Procedures.

2.2 FRAMELESS GLAZED INTERIOR WALL AND DOOR ASSEMBLIES

A. Frameless Glazed Interior Wall Assembly: Factory fabricated assemblies consisting of full-width and height glass panels fastened with U-channel fittings on top and bottom edge of glass wall.
   1. Configuration: As indicated on drawings.
   2. U-Channel Fittings: Extruded aluminum, satin anodized finish, dry glazed, and with matching end caps.
      a. Top channel is 1-1/2 inch (38 mm) high by 1 inch (25.4 mm) deep.
      b. Bottom channel is 1 inch (25.4 mm) high by 1 inch (25.4 mm) deep.
   3. Glass Thickness: 1/2 inch (12.7 mm), tempered.
   4. Designed to withstand normal operation without damage, racking, sagging, or deflection.
   5. Coordinate wall and door assembly preparation and provide hardware as necessary for fully operable installation.
   6. Finished metal surfaces protected with strippable film.
   7. Factory assembled to greatest extent practical; may be disassembled to accommodate shipping constraints.

B. Pivoting Glass Doors: Dry glazed patch fittings.
   1. Door Configuration: As indicated on drawings.
   2. Height: 2 inch (51 mm).
   3. Length: 6-7/16 inch (164 mm).
   5. Glass Thickness: 1/2 inch (12.7 mm), tempered.
   7. Closer: CRL Jackson Overhead Concealed Closer
8. Provide accessories as required for complete installation.

E. Other Manufacturers: Must be submitted for prior approval.

2.3 FITTINGS AND HARDWARE
A. Operable Panel Hardware: As required.

2.4 MATERIALS
A. Glass: Flat glass meeting requirements of Section 088000 “Glazing”
B. Aluminum Components: Conforming to ASTM B221 (ASTM B221M), Alloy 6063, T5 Temper.
C. Sealant: One-part silicone sealant, conforming to ASTM C920, clear.

2.5 FINISHES
A. Class I Natural Anodized Finish: AAMA 611 AA-M12C22A41 Clear anodic coating not less than 0.7 mils (0.018 mm) thick.

PART 3 - EXECUTION
3.1 EXAMINATION
A. Verify that field measurements are as indicated.
B. Verify that track supports are properly braced, level within 1/4 inch (6 mm) of required position and parallel to the floor surface.
C. Verify floor flatness of 1/8 inch in 10 feet (3 mm in 3 m), non-cumulative.
D. Do not begin installation until supports and adjacent substrates have been properly prepared.
E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION
A. Clean substrates thoroughly prior to installation.
B. Prepare substrates using the methods recommended by the manufacturer for achieving acceptable result for the substrate under the project conditions.

3.3 INSTALLATION
A. Install in accordance with glazed interior wall and door assembly manufacturer’s instructions.
B. Fit and align glazed interior wall and door assembly level and plumb.

3.4 ADJUSTING
A. Adjust glazed interior wall and door assembly to operate smoothly from sliding or pivoting positions.
B. Adjust swing door hardware for smooth operation.

3.5 CLEANING
A. Clean installed work to like-new condition.
B. See Section 017700 - Closeout Procedures, for additional requirements.

3.6 CLOSEOUT ACTIVITIES
A. See Section 017700 - Closeout Procedures, for closeout submittals.
B. Demonstrate operation of glazed interior wall and door assembly and identify potential operational problems.

3.7 PROTECTION
A. Protect installed products until completion of project.

GLAZED INTERIOR WALL AND DOOR ASSEMBLIES 102310 - 3
B. Touch-up, repair or replace damaged products before date of Substantial Completion.

END OF SECTION 102310
SECTION 102800 - TOILET, BATH, AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section Includes:
      1. Public-use washroom accessories.
   B. Related Sections:
      1. Division 08 Section "Mirrors" for frameless mirrors.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product indicated. Include the following:
      1. Construction details and dimensions.
      2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
      3. Material and finish descriptions.
      4. Features that will be included for Project.
      5. Manufacturer's warranty.
   B. Samples: Full size, for each accessory item to verify design, operation, and finish requirements.
      1. Approved full-size Samples will be returned and may be used in the Work.
   C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
      1. Identify locations using room designations indicated.
      2. Identify products using designations indicated.

1.4 INFORMATIONAL SUBMITTALS
   A. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS
   A. Maintenance Data: For toilet and bath accessories to include in maintenance manuals.
1.6 QUALITY ASSURANCE

A. Source Limitations: For products listed together in the same Part 2 articles, obtain products from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 COORDINATION

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

1.8 WARRANTY

A. Special Mirror Warranty: Manufacturer’s standard form in which manufacturer agrees to replace mirrors that develop visible silver spoilage defects and that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Stainless Steel: ASTM A 666, Type 304, 0.031-inch (0.8-mm) minimum nominal thickness unless otherwise indicated.

B. Brass: ASTM B 19, flat products; ASTM B 16/B 16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B 30, castings.

C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.036-inch (0.9-mm) minimum nominal thickness.

D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 (Z180) hot-dip zinc coating.


F. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.

G. Chrome Plating: ASTM B 456, Service Condition Number SC 2 (moderate service).

H. Mirrors: ASTM C 1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.2 PUBLIC-USE WASHROOM ACCESSORIES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
5. GAMCO Specialty Accessories; a division of Bobrick Washroom Equipment, Inc.
6. Tubular Specialties Manufacturing, Inc.

B. Toilet Tissue (Roll) Dispenser TP1:

1. Basis-of-Design Product:
   a. TP1 - Bobrick; B-6637
2. Description: Spindle holds rolls up to 5”, recessed cabinet holds spare roll
3. Mounting: Recessed
4. Capacity: Designed 5-inch (114- or 127-mm-) diameter tissue rolls
5. Material and Finish: Type 304 stainless steel, satin finish

C. Paper Towel Dispenser TD1:

1. Basis-of-Design Product:
   a. TD1 – Bobrick; B-3803; Recessed w/ waste receptacle
2. Description: Adjustable to dispense C-fold, multifold, or singlefold paper towels
3. Minimum Capacity: 600 C-fold, 800 multifold, or 1100 singlefold paper towels
4. Material and Finish: Type 304 stainless steel, satin finish
5. Lockset: Tumbler type

D. Liquid-Soap Dispenser SD1:

   a. Basis-of-Design Product: Mirabelle; MIRSD1188SS
   b. Description: Designed for dispensing soap, filled from the top.
   c. Mounting: Deck mounted on vanity and vertically oriented.
   d. Capacity: 17.6 oz.
   e. Materials: Brass soap head, stainless steel finish.

E. Grab Bar GB36, where 36 indicates length in inches:

1. Basis-of-Design Product: Bobrick; B-5806 Series
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
   a. Finish: Smooth, No. 4, satin finish
4. Outside Diameter: 1-1/4 inches (32 mm)
5. Configuration and Length: GB36 – Straight, 36 inches (915 mm)

F. Grab Bar GB42, where 42 indicates length in inches:

1. Basis-of-Design Product: Bobrick; B-5806 Series
3. Material: Stainless steel, 0.05 inch (1.3 mm) thick.
a. Finish: Smooth, No. 4, satin finish

4. Outside Diameter: 1-1/4 inches (32 mm)
5. Configuration and Length: GB42 – Straight, 42 inches (1065 mm) long

G. Sanitary-Napkin Disposal Unit SN1:
1. Basis-of-Design Product:
   a. SN 1 - Bobrick, B-3513

2. Mounting: Recessed
3. Door or Cover: Self-closing door with international graphic symbol pulls down for access to disposal
4. Receptacle: Removable
5. Material and Finish: Type 304 stainless steel, satin finish

H. Mop and Broom Holder MS1:
1. MS1
   a. Basis-of-Design Product: Bobrick B-223;
      1) Description: Wall mounted unit with holders.
      2) Length: 24 inches (610 mm)
      3) Mop/Broom Holders: Four spring-loaded, rubber hat, cam type.
      4) Material and Finish: Stainless steel, No. 4 finish (satin).

I. Mirror Unit FRMR:
1. Basis-of-Design Product: Provide mirror as indicated on Drawings
2. Size: As indicated on Drawings

2.3 FABRICATION

A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

B. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner’s representative.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Grab Bars: Install to withstand a downward load of at least 250 lbf (1112 N), when tested according to ASTM F 446.
3.2 ADJUSTING AND CLEANING

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
B. Remove temporary labels and protective coatings.
C. Clean and polish exposed surfaces according to manufacturer’s written recommendations.

END OF SECTION 102800
SECTION 104413 - FIRE EXTINGUISHER CABINETS

PART 1 - GENERAL

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

1.2 SUMMARY
A. Section Includes:
   1. Fire protection cabinets for the following:
      a. Portable fire extinguishers.
B. Related Sections:
   1. Division 09 painting Sections for field painting fire protection cabinets.
   2. Division 10 Section "Fire Extinguisher.""
2. Extruded Shapes: ASTM B 221 (ASTM B 221M).

B. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 3 mm thick, with Finish 1 (smooth or polished)

C. Acrylic Bubble: One piece.

2.2 FIRE PROTECTION CABINET

A. Cabinet Type: Suitable for fire extinguisher.

   B. “FE1” Basis Of Design: Subject to compliance with requirements, provide Larsen’s Manufacturing Company: AL2409-R1 Recessed Vertical Duo Clear Acrylic Door

B. Cabinet Construction: Nonrated.

C. Cabinet Material: Clear Anodized Aluminum sheet.

D. Cabinet Trim Material: Same material and finish as door.

E. Door Material: Clear Anodized Aluminum sheet.

F. Door Style: Vertical duo panel with frame.

G. Door Glazing: Acrylic sheet.

   1. Acrylic Sheet Color: Clear transparent acrylic sheet.

H. Door Hardware: Manufacturer’s standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

   1. Provide manufacturer’s standard.
   2. Provide manufacturer’s standard hinge permitting door to open 180 degrees.

I. Accessories:

   1. Mounting Bracket: Manufacturer’s standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
   2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated.

      a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."

         1) Location: Applied to cabinet door.
         2) Application Process: Manufacturer’s standard.
         3) Lettering Color: White.
         4) Orientation: Type A.

J. Finishes:
1. Aluminum: Clear anodic.

2.3 FABRICATION

A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

1. Weld joints and grind smooth.
2. Provide factory-drilled mounting holes.
3. Prepare doors and frames to receive locks.
4. Install door locks at factory.

B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
2. Miter and weld perimeter door frames.

C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.4 GENERAL FINISH REQUIREMENTS

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

B. Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

C. Finish fire protection cabinets after assembly.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.5 ALUMINUM FINISHES

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

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

B. Proceed with installation only after unsatisfactory conditions have been corrected.
3.2 PREPARATION

A. Prepare recesses for recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

A. General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below.

1. Fire Protection Cabinets: 54 inches above finished floor to top of cabinet.

B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.

1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
2. Provide inside latch and lock for break-glass panels.
3. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.

C. Identification: Apply decals or vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.

B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.

C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.

E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104413
SECTION 104416 - FIRE EXTINGUISHERS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. Section includes portable, hand-carried fire extinguishers.
   B. Related Sections:
      1. Division 10 Section "Fire Extinguisher Cabinets."

1.3 QUALITY ASSURANCE
   A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire
      Extinguishers."
   B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent
      testing agency acceptable to authorities having jurisdiction.
      1. Provide fire extinguishers approved, listed, and labeled by FMG.

1.4 COORDINATION
   A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and
      function.

PART 2 - PRODUCTS

2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS
   A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet and/or mounting
      bracket indicated.
      1. Manufacturers: Subject to compliance with requirements, provide products by one of the
         following:
         a. Badger Fire Protection; a Kidde company.
         c. Kidde Residential and Commercial Division; Subsidiary of Kidde plc.
         d. Larsen's Manufacturing Company.
2. Valves: Manufacturer's standard.
3. Handles and Levers: Manufacturer's standard.
4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B and bar coding for documenting fire extinguisher location, inspections, maintenance, and recharging.

B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 2-A:10-B:C, 5-lb (2.3-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

2.2 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Badger Fire Protection; a Kidde company.
   c. Larsen's Manufacturing Company.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

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

3.2 INSTALLATION

A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.

1. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.

B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Motor-operated roller shades with single rollers.

B. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Motorized Shades:
   a. Where motorized shades are to be controlled by control systems provided under other sections, coordinate the work with other trades to provide compatible products.
   b. Coordinate the work with other trades to provide rough-in for electrical wiring as required for installation of motorized shades.

2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

B. Preinstallation Meeting: Conduct on-site meeting with shade control system installer prior to commencing work to review:

1. Low voltage wiring requirements.
2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Control locations.
5. Connections to other equipment.
6. Installer responsibilities.
7. Pocket and/or mounting conditions.

C. Sequencing:

1. Do not fabricate shades until field dimensions for each opening have been taken.
2. Do not install shades until final surface finishes and painting are complete.
3. Motorized Shade Controls: Do not install wall controls until final surface finishes and painting are complete.
1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.

B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
   1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.

D. Samples for Initial Selection: For each type and color of shadeband material.
   1. Include Samples of accessories involving color selection.

E. Samples for Verification: For each type of roller shade.
   1. Shadeband Material: Not less than 3 inches (76 mm) square. Mark inside face of material if applicable.
   2. Roller Shade: Full-size operating unit, not less than 16 inches (400 mm) wide by 36 inches (900 mm) long for each type of roller shade indicated.
   3. Installation Accessories: Full-size unit, not less than 10 inches (250 mm) long.

F. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Product Certificates: For each type of shadeband material, signed by product manufacturer.

C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For roller shades to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.
1.7 QUALITY ASSURANCE

A. Installer Qualifications: Fabricator of products.

B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

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

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.10 WARRANTY

A. See Section 017700 – Closeout Submittals, for additional warranty requirements.

B. Manufacturer’s Warranty; Lutron 8-Year Limited Warranty:
1. Shade Control System Components (including shade electronic drive units, shade fabric, and shade hardware):
   a. Years 1-5: 100 percent replacement parts coverage, no manufacturer labor coverage.
   b. Years 6-8: 50 percent replacement parts coverage, no manufacturer labor coverage.
   c. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
2. External Shade Control System Components (including control stations, interfaces, and system accessories):
   a. One year 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a shade control issue.
   b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

B. **Basis-of-Design Product**: Subject to compliance with requirements, provide Lutron Electronics Company, Inc; Contract Roller; www.lutron.com/sle

C. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MOTOR-OPERATED, SINGLE-ROLLER SHADES

A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch, enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

B. General Requirements:
   1. Provide fully-factory assembled window shades complete with mounting brackets, operating mechanisms, hembars, hardware and accessories.
   2. Size: As indicated on drawings.
   3. Mounting: Jamb/recess mount within curtainwall mullions as indicated on drawings.
   4. Roller Tube: Manufacturer’s standard, selected for suitability for installation conditions, span, and weight of shades.
      b. Aluminum Recycled Content for Roller Tubes and Top Treatments:
         1) 50% post-industrial recycled content.
         2) 25% post-consumer recycled content.
         3) 25% primary aluminum
      c. Designed to prevent rust stains.
   5. Fabric Drop: Regular roll.
   7. Hembars: Wall thickness designed for weight requirements and adaptation to uneven surfaces, to maintain bottom of shade straight and flat.
      a. Style: Designer.
      b. Endcaps: Color to coordinate as recommended by manufacturer.

C. Motorized Shades:
   1. Product(s): Low-voltage wired shades with wired (low voltage) communications; Lutron Contract Roller: QS Motorized Shades.
   2. Listed as complying with UL 325.
   4. Audible Noise: Capable of operating at or below 44 dBA measured 3 feet from the center of the shade depending on the electronic drive unit selected; no audible clicks when motor starts and stops.
   5. Electronic Drive Units: Low-voltage, for connection to NFPA 70, Class 2 power source, by a qualified testing agency, and marked for intended location and application.
a. Size and configuration as recommended by manufacturer for the type, size, and arrangement of shades to be operated.
b. Concealed from interior view.

6. Coupling of Multiple Shades:
a. Where possible, minimize number of electronic drive units by coupling adjacent shades.
b. Utilize adjustable coupler that allows for precision adjustment of hembar levels without removing the installed roller or removing the fabric from the roller tube.

7. Adjustment Provisions:
a. Sub-brackets support shade during installation and allow for lateral position adjustment for consistent light gaps.
b. Level adjustment screws at each idler position allow for level adjustment without requiring shimming of shade brackets.

2.3 MOTORIZED SHADE CONTROLS

A. Motorized shades to be controlled by control stations and associated accessories as specified below.

B. General Requirements:
1. Provide products listed, classified, and labeled by Underwriter’s Laboratories Inc. (UL) as suitable for the purpose indicated.
2. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
3. System Capacity:
a. Supports up to 100 wired devices including shades, control stations, and power supplies.
b. Supports wireless devices within range of the wireless control.
c. Supports up to 100 wired zones.

4. Shade Control Requirements:
a. Capable of operating shades and recalling shade presets via keypad, contact closure input, infrared receiver, lighting management system software, or other lighting control system interface.
b. Capable of operating any individual, group, or subgroup of shade electronic drive units within system without requiring separate group controllers.
c. Capable of assigning and reassigning individual, groups, and subgroups of shades to any control within system without requiring additional wiring or hardware changes.
d. Capable of controlling shade speed for tracking within plus or minus 0.125 inch throughout entire travel.
e. Provide 10 year power failure memory for preset stops, open and close limits, shade grouping and subgrouping and system configuration.
f. Capable of synchronizing multiple shade electronic drive units regardless of drive or tube size to start, stop, and move in unison.
g. Capable of stopping shades within accuracy of .0125 inch at any point between open and close limits.
h. Capable of storing up to 250 programmable stop points, including open, close, and any other position.

5. Design shade control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F to 104 degrees F and 90% non-condensing relative humidity.
6. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
7. Device Finishes:
a. Wall controls: As selected by Architect from full manufacturer’s range.
b. Standard Colors: Comply with NEMA WD 1 where applicable.
c. Color Variation in Same Product Family: Maximum delta E of 1, CIE L*a*b color units per ASTM E308.
d. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

8. Provide all components and connections necessary to interface with other systems as indicated.

C. Keypads:
1. General Requirements:
   a. Allows control of any devices part of the shade control system.
   b. Allows for easy reprogramming without replacing unit.
   c. Buttons/Engraving:
      1) Engrave keypads with button, zone, and scene descriptions. Coordinate with Architect.
      2) Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
   d. Software configuration:
      1) Customizable control station device button functionality:
         a) Buttons can be programmed to perform single defined action.
         b) Buttons can be programmed to perform defined action on press and defined action on release.
   e. Status LEDs:
      1) Upon button press, LEDs to immediately illuminate.
      2) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
      3) Support logic that defines when LED is illuminated:
         a) Scene logic (logic is true when all zones are at defined levels).
         b) Last scene (logic is true when spaces are in defined scenes).

D. Wireless (Radio Frequency) Controls; Lutron Pico Wireless Controls:
1. Product(s):
   a. 3-Button with Raise/Lower Control; Lutron Pico Wireless Control Model PJ2-3BRL.
      1) Button Marking: Shade
2. Quantity: As indicated on the drawings.
3. Communicates via radio frequency to compatible window treatments.
4. Does not require external power packs, power or communication wiring.
5. Allows for easy reprogramming without replacing unit.
6. Single action button programming. Includes LED to indicate button press or programming mode status.
7. Mounting:
   a. Capable of being mounted with a table stand or directly to a wall under a faceplate.
   b. Faceplates: provide concealed mounting hardware.
8. Power: Battery-operated with minimum ten-year battery life.

E. Low-Voltage Control Interfaces:
1. Provide low-voltage control interfaces as indicated or as required to control the loads as indicated.
2. UL listed.
3. Sensor Modules:
   a. Products:
1) Sensor module with wireless inputs only; Lutron Model QSM2-XW-C.

b. Wireless Modules:
   1) Provide wireless communication inputs for:
      a) Wireless controller.
   2) RF Range: 30 feet between sensor and compatible RF receiving devices.
   3) RF Frequency: 434 MHz; operates in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.

c. Communicates sensor information to wired low-voltage digital link or use by compatible devices.

F. Power Supplies: Provide as indicated or as required to power system devices and accessories.
   1. Product(s):
      a. Ten output power supply panel for shades, keypads, and accessories, and for providing additional low voltage power to communication link; Lutron Model QSPS-10PNL; no replaceable fuses required for overload/miswire protection; automatically resets after overload trip; contains DOE Level VI Compliant power supplies.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.

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

3.2 ROLLER-SHADE INSTALLATION

A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
   1. Opaque Shadebands: Located so shadeband is not closer than the minimum recommended manufacturer dimension to interior face of glass.
   2. Coordinate with window installation and placement of concealed blocking to support shades.
   3. Coordinate low voltage wiring through window mullions for concealed appearance.

B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

C. Motorized Shade Control Installation:
   1. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.
   2. Adjust open and closed limits set by the manufacturer as required.
   3. Assign each shade to a shade group and set control functions.
   4. Identify system components in accordance with Section 260553.
3.3 ADJUSTING

A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.

C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 122413
SECTION 123623.13 - PLASTIC-LAMINATE-CLAD COUNTERTOPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes plastic-laminate countertops.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including panel products high-pressure decorative laminate adhesive for bonding plastic laminate and fire-retardant-treated materials.
   1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
   1. Show locations and sizes of cutouts and holes for electrical switches and outlets and other items installed in plastic-laminate countertops.

C. Samples for Initial Selection:
   1. Plastic laminates.

D. Samples for Verification:
   1. Plastic laminates, 12 by 12 inches (300 by 300 mm), for each type, color, pattern, and surface finish with one sample applied to core material [and specified edge material applied to one edge].
   2. Wood-grain plastic laminates, 24 by 24 inches (600 by 600 mm), for each type, pattern and surface finish, with one sample applied to core material and specified edge material applied to one edge.

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of product.

B. Evaluation Reports: For fire-retardant-treated materials, from ICC-ES.
1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

1.7 FIELD CONDITIONS

A. Environmental Limitations: Do not deliver or install countertops until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where countertops are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Established Dimensions: Where countertops are indicated to fit to other construction, establish dimensions for areas where countertops are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

PART 2 - PRODUCTS

2.1 PLASTIC-LAMINATE COUNTERTOPS

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

1. The Contract Documents contain selections chosen from options in the quality standard and additional requirements beyond those of the quality standard. Comply with those selections and requirements in addition to the quality standard.

B. Grade: Custom

C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
   a. Formica Corporation.

A. Colors, Patterns, and Finishes: Provide materials and products as scheduled in finish legend.

B. Edge Treatment: Laminate to match counter top.

C. Core Material: Particleboard

D. Core Material at Sinks: Particleboard made with exterior glue

E. Core Thickness: 3/4 inch (19 mm)
   1. Build up countertop thickness to 1-1/2 inches (38 mm) at front, back, and ends with additional layers of core material laminated to top.

F. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.


2.2 WOOD MATERIALS

A. Wood Products: Provide materials that comply with requirements of referenced quality standard unless otherwise indicated.

1. Wood Moisture Content: 8 to 13 percent.

2.3 ACCESSORIES

A. Grommets for Cable Passage through Countertops: 2-inch (51-mm) molded-plastic grommets and matching plastic caps with slot for wire passage.

1. Product: Subject to compliance with requirements, provide "TG series" by Doug Mockett & Company, Inc.

2.4 MISCELLANEOUS MATERIALS

A. Adhesives: Do not use adhesives that contain urea formaldehyde.

B. Adhesive for Bonding Plastic Laminate: PVA.

1. Adhesive for Bonding Edges: adhesive specified above for faces.

C. VOC Limits for Installation Adhesives and Sealants: Use products that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):

1. Wood Glues: 30 g/L.
2. Multipurpose Construction Adhesives: 70 g/L.
3. Structural Wood Member Adhesive: 140 g/L.
4. Architectural Sealants: 250 g/L.
2.5 FABRICATION

A. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

B. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets. Ease edges to radius indicated for the following:
   1. Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.

C. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Notify Architect seven days in advance of the dates and times woodwork fabrication will be complete.
   2. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements before disassembling for shipment.

D. Shop cut openings to maximum extent possible to receive appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition countertops to average prevailing humidity conditions in installation areas.

B. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

A. Grade: Install countertops to comply with same grade as item to be installed.

B. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
   1. Provide cutouts for appliances, plumbing fixtures, electrical work, and similar items.
   2. Seal edges of cutouts by saturating with varnish.

C. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
1. Secure field joints in plastic-laminate countertops with concealed clamping devices located within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.

D. Install countertops level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).

E. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

F. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
2. Secure backsplashes to walls with adhesive.
3. Seal junctures of tops, splashes, and walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective countertops, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean countertops on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 123623.13
SECTION 123661.16 - SOLID SURFACE FABRICATIONS

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following horizontal and trim solid surface product types:
      1. Reception areas

   B. Related Sections include the following:
      1. Division 5 Section “Metal Fabrications” for Blocking.
      2. Division 6 Section “Miscellaneous Rough Carpentry” for Blocking.

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

1.4 SUBMITTALS
   A. Product data:
      1. For each type of product indicated.
   B. Shop drawings:
      1. Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices and other components.
         a. Show full-size details, edge details, thermoforming requirements, attachments, etc.
         b. Show locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
         c. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in solid surface.
   C. Samples:
      1. For each type of product indicated.
         a. Submit minimum 6-inch by 6-inch sample in specified gloss.
         b. Cut sample and seam together for representation of inconspicuous seam.
         c. Indicate full range of color and pattern variation.
      2. Approved samples will be retained as a standard for work.
   D. Product data:
      1. Indicate product description, fabrication information and compliance with specified performance requirements.
   F. Product certificates:
      1. For each type of product, signed by product manufacturer.
   G. Fabricator/installer qualifications:
      1. Provide copy of certification number.
   H. Manufacturer certificates:
      1. Signed by manufacturers certifying that they comply with requirements.
   J. Maintenance data:
1. Submit manufacturer’s care and maintenance data, including repair and cleaning instructions.
   a. Maintenance kit for finishes shall be submitted.
2. Include in project closeout documents.

1.5 QUALITY ASSURANCE
A. Qualifications:
   1. Shop that employs skilled workers who custom fabricate products similar to those required for this project and whose products have a record of successful in-service performance.
B. Fabricator/installer qualifications:
   1. Work of this section shall be by a certified fabricator/installer, certified in writing by the manufacturer.
C. Applicable standards:
   1. Standards of the following, as referenced herein:
      a. American National Standards Institute (ANSI)
      b. American Society for Testing and Materials (ASTM)
      c. National Electrical Manufacturers Association (NEMA)
      d. NSF International
   2. Fire test response characteristics:
      a. Provide with the following Class A (Class I) surface burning characteristics as determined by testing identical products per UL 723 (ASTM E84) or another testing and inspecting agency acceptable to authorities having jurisdiction:
         1) Flame Spread Index: 25 or less.
         2) Smoke Developed Index: 450 or less.
D. Coordination drawings:
   1. Shall be prepared indicating:
      a. Plumbing work.
      b. Electrical work.
      c. Miscellaneous steel for the general work.
      d. Indicate location of all walls (rated and non-rated), blocking locations and recessed wall items, etc.
   2. Content:
      a. Project-specific information, drawn accurately to scale.
      b. Do not base coordination drawings on reproductions of the contract documents or standard printed data.
      c. Indicate dimensions shown on the contract drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements.
      d. Provide alternate sketches to designer for resolution of such conflicts.
         1) Minor dimension changes and difficult installations will not be considered changes to the contract.
E. Drawings shall:
   1. Be produced in 1/2-inch scale for all fabricated items.
F. Drawings must be complete and submitted to the architect within 60 days after award of contract for record only.
   1. No review or approval will be forthcoming.
   2. Coordination drawings are required for the benefit of contractor’s fabricators/installers as an aid to coordination of their work so as to eliminate or reduce conflicts that may arise during the installation of their work.
H. Pre-installation conference:
   1. Conduct conference at project site to comply with requirements in Division 1.

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

1.7 WARRANTY
   A. Provide manufacturer’s warranty against defects in materials.
      1. Warranty shall provide material and labor to repair or replace defective materials.
      2. Damage caused by physical or chemical abuse or damage from excessive heat will not be warranted.

1.8 MAINTENANCE
   A. Provide maintenance requirements as specified by the manufacturer.

PART 2 - PRODUCTS

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

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

   B. Thickness:
      2. 1/2 inch

2.3 ACCESSORIES
   A. Joint adhesive:
      1. Manufacturer’s standard one- or two-part adhesive kit to create inconspicuous, nonporous joints.

   B. Sealant:
      1. Manufacturer’s standard mildew-resistant, FDA-compliant, NSF 51-compliant (food zone — any type), UL-listed silicone sealant in colors matching components.

   D. Conductive tape:
      1. Manufacturer’s standard aluminum foil tape, with required thickness, for use with cutouts near heat sources.

   E. Insulating felt tape:
      1. Manufacturer’s standard for use with conductive tape in insulating solid surface material from adjacent heat source.

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

2.5 FINISHES
   A. Select from the manufacturer’s standard color chart.
      1. Color:
         a. As scheduled.
   B. Finish:
      1. Provide surfaces with a uniform finish.
         a. Polished.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine substrates and conditions, with fabricator present for compliance with
      requirements for installation tolerances and other conditions affecting performance of
      work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

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

3.3 REPAIR
   A. Repair or replace damaged work which cannot be repaired to architect’s satisfaction.

3.4 CLEANING AND PROTECTION
   A. Keep components clean during installation.
   B. Remove adhesives, sealants and other stains.

END OF SECTION 123661.16
SECTION 123661.19 - QUARTZ SURFACE FABRICATIONS

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following horizontal and trim quartz surface product types:
1. Countertops with or without undermount bowls
2. Vanity tops
3. Tabletops
4. Bar tops
B. Related Sections include the following:
1. Division 5 Section “Metal Fabrications” for Blocking.
2. Division 6 Section “Miscellaneous Rough Carpentry” for Blocking.
3. Division 6 Section “Solid Surface Fabrications.”

1.3 SUBMITTALS
A. Product data:
1. For each type of product indicated.
B. Shop drawings:
1. Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices and other components.
   a. Show the following:
      1) Full-size details, edge details, attachments, etc.
      2) Locations and sizes of furring, blocking, including concealed blocking and reinforcement specified in other Sections.
      3) Locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers, waste receptacle and other items installed in quartz surface.
      4) Seam locations.
C. Samples:
1. For each type of product indicated:
   a. Submit minimum 6-inch by 6-inch sample in specified color.
   b. Cut sample and seam together for representation of seaming techniques.
   c. Indicate full range of color and pattern variation.
2. Approved samples will be retained as a standard for work.
D. Product data:
1. Indicate product description, fabrication information and compliance with specified performance requirements.
F. Product certificates:
1. For each type of product, signed by product manufacturer.
G. Fabricator/installer qualifications:
1. Provide copy of certification number.
H. Manufacturer certificates:
1. Signed by manufacturers certifying that they comply with requirements.
J. Maintenance data:
1. Submit manufacturer’s care and maintenance data.
   a. Maintenance kit for finishes shall be submitted.
2. Include in project closeout documents.
1.4 QUALITY ASSURANCE

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

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

C. Applicable standards:
   1. Standards of the following, as referenced herein:
      a. American National Standards Institute (ANSI)
      b. American Society for Testing and Materials (ASTM)
      c. National Electrical Manufacturers Association (NEMA)
      d. NSF International
   2. Fire test response characteristics:
      a. Provide with the following Class A (Class I) surface burning characteristics as determined by testing identical products per UL 723 (ASTM E 84) or another testing and inspecting agency acceptable to authorities having jurisdiction.
      b. Flame Spread Index: 25 or less.
      c. Smoke Developed Index: 450 or less.

D. Allowable tolerances:
   1. Variation in component size: ±1/8" (3 mm) over a 10' length.
   2. Location of openings: ±1/8" (3 mm) from indicated location.
   3. Maximum 1/8" (3 mm) clearance between quartz surfaces and each wall.

E. Coordination drawings:
   1. Shall be prepared indicating:
      a. Plumbing work.
      b. Electrical work.
      c. Miscellaneous steel for the general work.
      d. Indicate location of all walls (rated and non-rated), blocking locations and recessed wall items, etc.
   2. Content:
      a. Project-specific information, drawn accurately to scale.
      b. Do not base coordination drawings on reproductions of the contract documents or standard printed data.
      c. Indicate dimensions shown on the contract drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements.
      d. Provide alternate sketches to designer for resolution of such conflicts.
         1) Minor dimension changes and difficult installations will not be considered changes to the contract.
   3. Drawings shall:
      a. Be produced in 1/2" scale for all fabricated items.
   4. Drawings must be complete and submitted to the architect within 60 days after award of contract for record only.
      a. No review or approval will be forthcoming.
      b. Coordination drawings are required for the benefit of contractor's fabricators/installers as an aid to coordination of their work so as to eliminate or reduce conflicts that may arise during the installation of their work.

G. Pre-installation conference:
   1. Conduct conference at project site to comply with requirements in Division 1.

1.5 DELIVERY, STORAGE AND HANDLING

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

1.6 WARRANTY
A. Provide manufacturer’s 10-year warranty against defects in materials.
   1. Warranty shall provide material to repair or replace defective materials.
   2. Damage caused by physical or chemical abuse or damage from excessive
      heat will not be warranted.

1.7 MAINTENANCE
A. Provide maintenance requirements as specified by the manufacturer.

PART 2 - PRODUCTS
2.1 MANUFACTURERS
A. Subject to compliance with the requirements, provide the following product:
   1. Zodiaq® quartz surfaces from DuPont (basis of design)
   2. VICOSTONE quartz surfaces (basis of design)

2.2 MATERIALS
A. Material:
   1. Homogeneous quartz surfaces material.
   2. Material shall have minimum physical and performance properties specified.

B. Thickness:
   1. 3 cm.

C. Edge treatment:
   1. As scheduled.

2.3 ACCESSORY PRODUCTS
A. Joint adhesive:
   1. DuPont-approved adhesive to create color-matched seam.

B. Sink/bowl mounting hardware:
   1. Manufacturer’s approved bowl clips, brass inserts and fasteners for
      attachment of undermount sinks/bowls.

2.4 FACTORY FABRICATION
A. Shop assembly
   1. Fabricate components to greatest extent practical to sizes and shapes
      indicated, in accordance with approved shop drawings and manufacturer’s
      printed instructions and technical bulletins.
   2. Form joints between components using manufacturer’s standard joint adhesive
      joints.
      a. Reinforce as required.
   3. Provide factory cutouts for plumbing fittings and bath accessories as indicated
      on the drawings.
   4. Rout and finish component edges with clean, sharp returns.
      a. Rout cutouts, radii and contours to template.
      b. Smooth edges.
2.5 FINISHES
   A. Select from the manufacturer's standard color chart.
      1. Color:
         a. As scheduled.

PART 3 - EXECUTION

3.1 INSTALLATION
   A. Install components plumb and level, in accordance with approved shop drawings and
      product installation details.
      1. Tops:
         a. Flat and true to within 1/8" (3 mm) of a flat surface over a 10' length.
         b. Allow a minimum of 1/16" to a maximum of 1/8" (3 mm) clearance between surface and each wall.
   B. Form field joints using manufacturer's recommended adhesive, with joint widths no
      greater than 1/8" (3 mm) in finished work.
      1. Keep components and hands clean when making joints.
   C. Sinks:
      1. Adhere undermount sinks/bowls to countertops using manufacturer's
         recommended adhesive and mounting hardware.
      2. Adhere drop-in sinks/bowls to countertops using manufacturer-recommended
         adhesives and color-matched silicone sealant.
   D. Provide backsplashes and endsplashes as indicated on the drawings.
      1. Adhere to countertops using manufacturer’s standard color-matched silicone
         sealant.
   E. Keep components and hands clean during installation.
      1. Remove adhesives, sealants and other stains.
      2. Components shall be clean on date of substantial completion.
   F. Connections:
      1. Make plumbing connections in accordance with Division 15.
      2. Make electrical connections in accordance with Division 16.

3.2 CLEANING AND PROTECTION
   A. Keep components clean during installation.
      1. Remove adhesives, sealants and other stains.
   B. Protect surfaces from damage until date of substantial completion.
      1. Replace damaged work.

END OF SECTION 123661.19
SECTION 22 05 23 – VALVES

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes general-duty valves.

1.3 QUALITY ASSURANCE
A. ASME Compliance: ASME B31.9 for building services piping valves.
B. ASME Compliance for Ferrous Valves: ASME B16.10 and ASME B16.34 for dimension and design criteria.
C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.4 DELIVERY, STORAGE, AND HANDLING
A. Prepare valves for shipping as follows:
1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.
B. Use the following precautions during storage:
1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 VALVES, GENERAL
A. Bronze Valves: NPS 2 and smaller with threaded ends, unless otherwise indicated.
B. Ferrous Valves: NPS 2-1/2 and larger with flanged ends, unless otherwise indicated.
C. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
D. Valve Sizes: Same as upstream pipe, unless otherwise indicated.

E. Valve Actuators:
   1. Lever Handle: For quarter-turn valves NPS 6 and smaller, except plug valves.
   2. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug head.

F. Extended Valve Stems: On insulated valves.


H. Valve Grooved Ends: AWWA C606.

I. Valve Bypass and Drain Connections: MSS SP-45.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves in positions from fully open to fully-closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE APPLICATIONS

A. Refer to piping Sections for specific valve applications. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, gate, or plug valves.
   2. Throttling Service: Angle, ball, butterfly or globe valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP class or CWP ratings may be substituted.
3.3 VALVE INSTALLATION

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

C. Locate valves for easy access and provide separate support where necessary.

D. Install valves in horizontal piping with stem at or above center of pipe.

E. Install valves in position to allow full stem movement. End chains to 60 inches above finished floor elevation.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.
   2. Dual-Plate Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with keyed coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

3.5 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

END OF SECTION 22 05 23
SECTION 22 07 00 - PIPE INSULATION

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
B. Related Sections include the following:
   1. Division 23 Section "Duct Insulation" for insulation for ducts and plenums.
   2. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

1.3 SUBMITTALS
A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

1.4 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."

B. Coordinate clearance requirements with piping installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing piping systems. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Mineral-Fiber Insulation:
   a. CertainTeed Manson.
   b. Knauf FiberGlass GmbH.
   c. Owens-Corning Fiberglas Corp.
   d. Schuller International, Inc.

2. Cellular-Glass Insulation:
   a. Pittsburgh-Corning Corp.

3. Flexible Elastomeric Thermal Insulation:
   a. Armstrong World Industries, Inc.
   b. Rubatex Corp.

4. Closed-Cell Phenolic-Foam Insulation:
   a. Kooltherm Insulation Products, Ltd.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.

B. Cellular-Glass Insulation: Inorganic, foamed or cellulated glass, annealed, rigid, hermetically sealed cells, incombustible.
   1. Preformed Pipe Insulation, without Jacket: Comply with ASTM C 552, Type II, Class 1.
   2. Preformed Pipe Insulation, with Jacket: Comply with ASTM C 552, Type II, Class 2.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Adhesive: As recommended by insulation material manufacturer.
   2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

D. Closed-Cell Phenolic-Foam Insulation: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.

E. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.


C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
   1. Adhesive: As recommended by insulation material manufacturer.
   2. PVC Jacket Color: White or gray.
   3. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.

D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.
   1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
   2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, pre-sized a minimum of 8 oz./sq. yd..

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
2. Galvanized Steel: 0.005 inch thick.
3. Aluminum: 0.007 inch thick.
4. Brass: 0.010 inch thick.
5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.
C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.
   1. Apply insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
   3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Circumferential Joints: Cover with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
   3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.

5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

Q. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

R. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Firestopping and fire-resistive joint sealers are specified in Division 7 Section "Firestopping."

S. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.

2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.

3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.5 CELLULAR-GLASS INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of the same thickness as pipe insulation.
4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:
1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded sections of insulation are not available, apply mitered sections of cellular-glass insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.
4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:
1. Apply premolded segments of cellular-glass insulation or glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.
2. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
5. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.6 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:
1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:
1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:
1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to strainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.7 CLOSED-CELL PHENOLIC-FOAM INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:
   1. Secure each layer of insulation to pipe with wire, tape, or bands without deforming insulation materials.
   2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic.
   3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:
   1. Apply preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of the same material and thickness as pipe insulation.
   4. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch, and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:
   1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When premolded sections of insulation are not available, apply mitered sections of phenolic-foam insulation. Secure insulation materials with wire, tape, or bands.
   3. Cover fittings with standard PVC fitting covers.
   4. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

D. Apply insulation to valves and specialties as follows:
   1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
   2. When premolded sections of insulation are not available, apply mitered segments of phenolic-foam insulation to valve body. Arrange insulation to permit access to packing.
and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to strainer basket without disturbing insulation.

3. Apply insulation to flanges as specified for flange insulation application.


5. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

6. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

3.8 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
   1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer's recommended adhesive.
   3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

B. Foil and Paper Jackets: Apply foil and paper jackets where indicated.
   1. Draw jacket material smooth and tight.
   2. Apply lap or joint strips with the same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Apply jackets with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

C. Apply PVC jacket where indicated, with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

D. Apply metal jacket where indicated, with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.9 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Division 9 Section "Painting."

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of the insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
3.10 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Drainage piping located in crawl spaces, unless otherwise indicated.
5. Below-grade piping, unless otherwise indicated.
6. Chrome-plated pipes and fittings, unless potential for personnel injury.
7. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.11 FIELD QUALITY CONTROL

A. Inspection: Perform the following field quality-control inspections, after installing insulation materials, jackets, and finishes, to determine compliance with requirements:

1. Inspect fittings and valves randomly selected by Architect.
2. Remove fitting covers from 20 elbows or 1 percent of elbows, whichever is less, for various pipe sizes.
3. Remove fitting covers from 20 valves or 1 percent of valves, whichever is less, for various pipe sizes.

B. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

C. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.12 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.13 INTERIOR INSULATION APPLICATION SCHEDULE

A. Service: Domestic hot water.

1. Operating Temperature: 60 to 140 deg F.
2. Insulation Material: Fiberglass, with jacket.
3. Insulation Thickness: Apply the following insulation thicknesses:
   a. Copper Pipe: 1” thick
5. Vapor Retarder Required: Yes.

B. Service: Condensate drain piping.
   1. Operating Temperature: 35 to 75 deg F.
   2. Insulation Material: Flexible elastomeric.
   3. Insulation Thickness: ½”
   5. Vapor Retarder Required: Yes.
   6. Finish: None.

C. 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: Flexible elastomeric.
   3. Insulation Thickness: ¾”
   5. Vapor Retarder Required: No.
   6. Finish: None.

D. Service: Refrigerant suction and hot-gas piping.
   1. Operating Temperature: 35 to 50 deg F.
   2. Insulation Material: Flexible elastomeric.
   3. Insulation Thickness: 0.75 inch.
   4. Field-Applied Jacket: None, interior; exterior as noted.
   5. Vapor Retarder Required: No.

E. Service: Domestic cold water.
   1. Operating temperature: 45 to 80 deg F.
   2. Insulation material: Mineral fiber.
   3. Insulation thickness: 0.5 inch.
   4. Field-Applied Jacket: ASJ.
   5. Vapor retarder required: Yes.
   6. Finish: None.

F. Service: Waste from floor and hub drains: Same as domestic cold water.

G. Service: Underside of roof drains.
   1. Operating temperature: 45 to 80 deg F.
   2. Insulation material: Mineral fiber.
   3. Insulation thickness: 0.5 inch.
   4. Jacket: ASJ.
   5. Vapor retarder required: Yes.
   6. Finish: None.

H. Service: Roof drain piping: 2” thick, ¾ pound density fiberglass duct wrap.
3.14 EXTERIOR INSULATION APPLICATION

A. All insulation outside, exposed to weather shall be covered with aluminum metal jacket. At joints, fittings, etc. only, a white elastomeric coating may be used.

END OF SECTION 22 07 00
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes domestic water piping from locations indicated to fixtures and equipment inside the building.

1.3 PERFORMANCE REQUIREMENTS
A. Provide components and installation capable of producing domestic water piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1.4 SUBMITTALS
A. Product Data: Required where indicated only. Submittal of pipe and fittings not required unless a change from specification is proposed.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances," and NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for combined fire-protection and domestic water service piping to building.
D. Comply with NSF 61, "Drinking Water System Components-Health Effects; Sections 1 through 9," for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
B. Transition Couplings for Aboveground Pressure Piping: Coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

C. Transition Couplings for Underground Pressure Piping: AWWA C219, metal, sleeve-type coupling or other manufactured fitting the same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

2.2 DUCTILE-IRON PIPING

A. Piping for fire-suppression applications shall be listed for fire-protection service.

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint, bell- and plain-spigot end, unless grooved or flanged ends are indicated.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron, standard pattern; or AWWA C153, ductile-iron, compact pattern.
   a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2. Ductile-Iron Piping, Grooved-End Fittings: ASTM A 47, malleable-iron castings or ASTM A 536 ductile-iron castings with dimensions matching pipe.
   a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint, bell- and plain-spigot end, unless grooved or flanged ends are indicated.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron, standard pattern; or AWWA C153, ductile-iron, compact pattern.

2. Ductile-Iron, Grooved-End Fittings: ASTM A 47, malleable-iron castings or ASTM A 536 ductile-iron castings with dimensions matching pipe.
   a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

3. Ductile-Iron, Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed, ball-joint sections and one or more gasketed, sleeve section. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

4. Ductile-Iron, Deflection Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

2.3 COPPER TUBING

A. Soft Copper Tube: ASTM B 88, Types L, water tube, annealed temper.

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.

B. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.

2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
4. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
   a. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

2.4 PE ENCASEMENT

A. PE Encasement for Underground Metal Piping: ASTM A674 or AWWA C105 PE film, 0.008-inch minimum thickness, tube or sheet.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Grooved joints may be used on aboveground grooved-end piping.

D. Fitting Option: Mechanically formed tee-branch outlets and brazed joints may be used on aboveground copper tubing.

E. Underground Domestic Water Piping: Use any of the following piping materials for each size range:

1. NPS 3-1/2 and smaller: PVC piping or soft copper tube, Type L copper pressure fittings; and soldered joints. Exterior to the building and outside of any concrete flatwork.
2. NPS 2 to NPS 4: Hard copper tube, Type L; wrought copper pressure fittings; and silver-fos soldered joints. Under the building slab and beneath any concrete flatwork.
3. NPS 1-1/2 and Smaller: Soft copper tube, Type L; Pipe joints to be avoided and permitted only to the extent of run lengths exceeding that of a single roll length of tubing. Should joints
be required use wrought copper pressure fittings and silver-fos soldered joints. Under the building slab or any other concrete flatwork.

F. Aboveground Domestic Water Piping: Use the following piping materials for each size range:
   1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

3.2 VALVE APPLICATIONS

A. Submittal required. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Shutoff Duty: Use bronze ball or gate valves for piping NPS 2 and smaller. Use cast-iron butterfly or gate valves with flanged ends for piping NPS 2-1/2 and larger.
   2. Drain Duty: Hose-end drain valves.

B. Cast-iron, grooved-end valves may be used with grooved-end piping.

3.3 PIPING INSTALLATION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Extend domestic water service piping to exterior water distribution piping in sizes and locations indicated.

C. Install underground ductile-iron piping according to AWWA C600, AWWA M41, and NFPA 24. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   1. Encase piping with polyethylene film according to ASTM A 674 or AWWA C105.

D. Install underground copper tubing according to CDA's "Copper Tube Handbook."

E. Install underground AWWA PVC piping according to NFPA 24, AWWA M23, and ASTM F 645. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

F. Install underground PVC piping according to ASTM D 2774 and ASTM F 645. Install buried piping inside building between wall and floor penetrations and connection to water service piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

G. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.

H. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for wall penetration systems.

I. Install aboveground domestic water piping level with 0.25 percent slope downward toward drain and plumb.
J. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

K. Perform the following steps before operation:
   1. Close drain valves and hydrants.
   2. Open shutoff valves to fully open position.
   3. Open throttling valves to proper setting.
   4. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
   5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
   6. Remove filter cartridges from housings, and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.

L. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

3.4 JOINT CONSTRUCTION
   A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.
   B. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.
   C. Grooved Joints: Assemble joints with keyed-coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.
   D. Mechanically Formed Outlets: Form tee in copper tube according to equipment manufacturer's written instructions. Use tool designed for copper tube; drill pilot hole, form collar for outlet, dimple tube to form seating stop, and braze branch tube into collar.

3.5 VALVE INSTALLATION
   A. Install sectional valve close to water main on each branch and riser serving plumbing fixtures or equipment. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
   B. Install shutoff valve on each water supply to equipment and on each water supply to plumbing fixtures without supply stops. Use ball or gate valves for piping NPS 2 and smaller. Use butterfly or gate valves for piping NPS 2-1/2 and larger.
   C. Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.
      1. Install hose-end drain valves at low points in water mains, risers, and branches.
      2. Install stop-and-waste drain valves where indicated.

3.6 HANGER AND SUPPORT INSTALLATION
   A. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices.
   B. Install supports according to Division 23 Section "Hangers and Supports."
C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, to a minimum of 3/8 inch.

E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 and smaller: 60 inches with 3/8-inch rod.
   2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
   3. NPS 1-1/2 and NPS 2-1/2: 96 inches with 3/8-inch rod.

F. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to service piping with shutoff valve, and extend and connect to the following:
   1. Water Heaters: Cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
   2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
   3. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

3.8 FIELD QUALITY CONTROL

A. Inspect domestic water piping as follows:
   1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test domestic water piping as follows:
1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced domestic water piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.9 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:

1. Purge new piping and parts of existing domestic water piping that have been altered, extended, or repaired before using.

2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction or, if methods are not prescribed, procedures described in either AWWA C651 or AWWA C652 or as described below:
   a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
   b. Fill and isolate system according to either of the following:
      1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 8 hours.
   c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
   d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Prepare and submit reports of purging and disinfecting activities.

C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

END OF SECTION 22 11 00
SECTION 221119 - PLUMBING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following plumbing specialties:

1. Roof flashing assemblies.
2. Key-operation hydrants.
3. Trap seal primer valves.
4. Miscellaneous piping specialties.
5. Cleanouts.
6. Floor drains.
7. Through-penetration fire-stop assemblies.
8. Roof drains and downspout nozzles.

1.3 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with following minimum working-pressure ratings, unless otherwise indicated:

1. Domestic Water Piping: 125 psig.

1.4 SUBMITTALS

A. Product Data: Include rated capacities and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following:

1. Water hammer arresters, air vents, and trap seal primer valves.
2. Drain valves and hydrants.
3. Cleanouts and floor drains.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field test reports.

D. Maintenance Data: For plumbing specialties to include in maintenance manuals. Include the following:

1. Trap seal primer valves.
2. Hydrants.
3. Roof drains and downspout nozzles.
1.5 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of plumbing specialties and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."

B. Plumbing specialties shall bear label, stamp, or other markings of specified testing agency.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for piping materials and installation.

E. NSF Compliance:

PART 2 PRODUCTS

2.1 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      Acorn Engineering Company; Elmdor/Stoneman Div.
      Thaler Metal Industries Ltd.
   B. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch thick, lead flashing collar and skirt extending at least 6 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.

2.2 KEY-OPERATION HYDRANTS

A. General: As scheduled, ASME A112.21.3M, key-operation hydrant with pressure rating of 125 psig.

B. Inlet: NPS 3/4 or NPS 1 threaded or solder joint.

D. Operating Keys: One with each key-operation hydrant.

2.3 TRAP SEAL PRIMER VALVES

A. Supply-Type Trap Seal Primer Valves: As scheduled, ASSE 1018, water-supply-fed type, with the following characteristics:

B. Manufacturers:
   1. Precision Plumbing Products, Inc.
   2. Mifab.
   3. Reference Section 224200 for additional alternate manufacturers.

C. 125-psig minimum working pressure.

D. Bronze body with atmospheric-vented drain chamber.

E. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.

F. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

G. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.4 MISCELLANEOUS PIPING SPECIALTIES

A. Water Hammer Arresters: ASSE 1010 or PDI-WH 201, piston type with pressurized metal-tube cushioning chamber. Sizes indicated are based on ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

B. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting, joined with ASTM C 564, rubber gaskets.

C. Deep-Seal Traps: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap seal primer valve connection.
   1. NPS 2: 4-inch- minimum water seal.
   2. NPS 2-1/2 and larger: 5-inch- minimum water seal.

D. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

E. Fixed Air-Gap Fittings: Manufactured cast-iron or bronze drainage fitting with semi-open top with threads or device to secure drainage inlet piping in top and bottom spigot or threaded outlet larger than top inlet. Include design complying with ASME A112.1.2 that will provide fixed air gap between installed inlet and outlet piping.

F. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing; of size and end types corresponding to connected piping.
2.5 CLEANOUTS

A. Cleanouts.

1. Application: Floor cleanout, Wall cleanout; for installation in exposed piping, and exterior cleanout.

2. Products:
   a. Floor Cleanout in finished areas: Tyler Pipe, Wade Div.; #W-7000 w/ satin nickel bronze top.
   b. Floor Cleanout in tile floors: Tyler Pipe, Wade Div.; #W-7000-T.
   c. Floor Cleanout in terrazzo floors: Tyler Pipe, Wade Div.; #W-7000-U.
   d. Floor Cleanout in unfinished utility or storage areas: Tyler Pipe, Wade Div.; #W-8550-D.
   e. Wall Cleanout: Tyler Pipe, Wade Div.; #W-8450-R w/ stainless steel cover plate.
   f. Cleanout in exposed piping: Tyler Pipe, Wade Div.; #W-8550-R.
   g. Exterior Cleanout: Tyler Pipe, Wade Div.; #W-7040-X w/ nickel bronze top.

3. Cleanouts in waterproof floors shall have flashing flange and clamping device.
4. Cleanouts in carpeted areas shall be provided with carpet makers (Wade option No. 72).
5. Reference Section 224200 for additional alternate manufacturers.

2.6 FLOOR DRAINS

A. Floor Drains, Wade Div. #W-1100, shall be provided as indicated on drawings.

2. Top or Strainer Material: Nickel bronze.
4. Top Shape: Round.
5. Trap Material: Cast iron.
7. Trap Features: Trap seal primer valve drain connection.
8. Reference Section 224200 for additional alternate manufacturers.

2.7 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a) ProSet Systems Inc.
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Special Coating: Corrosion resistant on interior of fittings.

PLUMBING SPECIALTIES 221119- 4
2.8 ROOF DRAINS

A. Metal Roof Drains/Downspout Nozzles:

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

   b. Josam.
   c. Mifab.
   d. Sioux Chief.
   e. Wade.
   f. Watts.
   g. Zurn

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for piping joining materials, joint construction, and basic installation requirements.

B. Install trap seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

C. Install expansion joints on vertical risers, stacks, and conductors if indicated.

D. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:

   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 75 feet.
   4. Locate at base of each vertical soil and waste stack.

E. Install cleanout deck plates with top flush with finished floor, for floor cleanouts for piping below floors.

F. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

G. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

H. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

I. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.

   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

J. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

K. Fasten recessed-type plumbing specialties to reinforcement built into walls.

L. Install wood-blocking reinforcement for wall-mounting and recessed-type plumbing specialties.

M. Install individual shutoff valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated. Install shutoff valves in accessible locations. Refer to Division 22 Section "Valves" for general-duty ball, butterfly, check, gate, and globe valves.

N. Install air vents at piping high points. Include ball, gate, or globe valve in inlet.

O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

P. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

Q. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.

   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect plumbing specialties to piping specified in other Division 22 and 23 Sections.

D. Ground equipment.

E. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer’s torque values are not indicated, use those specified in UL 486A and UL 486B.

F. Connect plumbing specialties and devices that require power according to Division 16 Sections.
3.3 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221119
SECTION 22 13 00 - SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes soil and waste, sanitary drainage and vent piping inside the building and to locations indicated.

1.3 PERFORMANCE REQUIREMENTS
A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1.4 SUBMITTALS
A. Product Data: For pipe, tube, fittings, and couplings.
B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.5 QUALITY ASSURANCE
A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS
A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
B. Flexible Transition Couplings for Underground Non-pressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.
2.2 CAST-IRON SOIL PIPING
   A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service class.

2.3 DUCTILE-IRON PIPING
   A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
      1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
         a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
      2. Ductile-Iron Piping, Grooved-End Fittings: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
         a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
   B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
      1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
      2. Ductile-Iron, Grooved-End Fittings: ASTM A 47, malleable-iron castings or ASTM A 536, ductile-iron castings with dimensions matching pipe.
         a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.
      3. Ductile-Iron, Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed ball-joint sections and one or more gasketed sleeve sections. Assemble components for offset and expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
      4. Ductile-Iron, Deflection Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

2.4 COPPER TUBING
   A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Hard Copper Tube: ASTM B88, Type M, water tube, drawn temper.

3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.5 PVC PIPING

A. PVC Pipe: ASTM D2665, Schedule 40, solid-wall drain, waste and vent (DWV).

1. PVC Socket Fittings: ASTM D2665, socket type, made to ASTM D3311 DWV patterns.

2.6 PE ENCASEMENT

A. PE Encasement for Underground Metal Piping: ASTM A674 or AWWA C105, PE film, 0.008-inch minimum thickness, tube or sheet.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground, Soil, Waste, and Vent Piping: Use any of the piping materials allowed in accordance with governing Plumbing Code unless otherwise noted.

D. Underground, Soil, Waste, and Vent Piping: Use any of the piping materials allowed in accordance with governing Plumbing Code unless otherwise noted.

3.3 PIPING INSTALLATION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewer. Install as indicated and as required by governing Plumbing Code.

C. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for wall penetration systems.
D. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

E. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

F. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated or dictated by local plumbing code:

1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

G. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

H. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.


1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Individual, Straight, Horizontal Piping Runs: According to the following:
   a. 100 feet and less: MSS Type 1, adjustable, steel clevis hangers.
   b. Longer than 100 feet: MSS Type 43, adjustable roller hangers.
   c. Longer than 100 feet, if indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 23 Section "Hangers and Supports."
C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4: 60 inches with 5/8-inch rod.
4. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4: 72 inches with 3/8-inch rod.
2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Fixtures."
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Division 22 Section "Plumbing Specialties."
4. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.
C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch WG. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.9 PROTECTION

A. Exposed Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint; color to match adjacent finish.

END OF SECTION 22 13 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes storm-drainage piping inside the building and to locations indicated.
B. Related Sections include the following:
   1. Division 22 Section "Plumbing Specialties" for storm drainage piping system specialties.

1.3 DEFINITIONS

A. The following are industry abbreviations for plastic piping materials:
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:
   1. Storm Drainage Piping: 10-foot head of water

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.
B. Shop Drawings: For controlled-flow storm drainage system, include calculations, plans, and details.
C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.6 QUALITY ASSURANCE

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
PART 2 - PRODUCTS

2.1 PIPING MATERIALS
   A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.
   B. Flexible Transition Couplings for Underground Non-pressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends of same sizes as piping to be joined and include corrosion-resistant metal band on each end.

2.2 CAST-IRON SOIL PIPING
   A. Hub-and-Spigot Pipe and Fittings: ASTM A 74, Service class.
   B. Hub-less Pipe and Fittings: ASTM A 888 or CISPI 301.
   C. Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve with integral center pipe stop.

2.3 STEEL PIPING
   A. Steel Pipe: ASTM A 53, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.

2.4 DUCTILE-IRON PIPING
   A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end, unless grooved or flanged ends are indicated.

2.5 PE ENCASEMENT
   A. PE Encasement for Underground Metal Piping: ASTM A 674 or AWWA C105 PE film, 0.008-inch minimum thickness, tube or sheet.

PART 3 - EXECUTION

3.1 EXCAVATION
   A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.
3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure ratings may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground Storm Drainage Piping: Use any of the following piping materials for each size range:

1. NPS 2 to NPS 4: Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. NPS 2 to NPS 4: Hubless, cast-iron soil piping and one of the following:
   a. Couplings: Heavy-duty, Type 304 stainless steel.
   b. Couplings: Heavy-duty, cast iron.
   c. Couplings: Compact, stainless steel.
3. NPS 2 to NPS 4: Steel pipe; cast-iron, threaded drainage fittings; and threaded joints.
4. NPS 2 to NPS 4: Cellular-core, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.
5. NPS 6 and NPS 8: Service class, cast-iron soil piping; gaskets; and gasketed joints.
6. NPS 6 and NPS 8: Hubless, cast-iron soil piping and one of the following:
   a. Couplings: Heavy-duty, Type 304 stainless steel.
   b. Couplings: Heavy-duty, cast iron.
   c. Couplings: Compact, stainless steel.
7. NPS 6 and NPS 8: Steel pipe; cast-iron, threaded drainage fittings; and threaded joints.
8. NPS 6 and NPS 8: Cellular-core, Schedule 40, PVC pipe; PVC socket fittings; and solvent-cemented joints.

3.3 PIPING INSTALLATION

A. Refer to "Storm Drainage" (Civil) for Project site storm sewer and drainage piping.

B. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation.

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. Encase piping with PE film according to ASTM A 674 or AWWA C105.

F. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for sleeves and mechanical sleeve seals.

G. Install wall penetration system at each service pipe penetration through foundation wall. Make installation watertight. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for wall penetration systems.
H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

I. Encase underground piping with PE film according to ASTM A 674 or AWWA C105.

J. Make changes in direction for storm piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drain piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:
   1. Building Storm Drain: 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
   2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

M. Install force mains at elevations indicated.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

   1. Gasketed Joints: Make with rubber gasket matching class of pipe and fittings.
   2. Hub-less Joints: Make with rubber gasket and sleeve or clamp.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 23 Section "Hangers and Supports" for pipe hanger and support devices. Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs: According to the following:
a. 100 Feet and less: MSS Type 1, adjustable, steel clevis hangers.
b. Longer than 100 feet: MSS Type 43, adjustable roller hangers.
c. Longer than 100 feet, if indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

B. Install supports according to Division 23 Section "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3: 12 feet with 1/2-inch rod.
   2. NPS 4: 12 feet with 5/8-inch rod.
   3. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.

F. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.7 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

   1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

   Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

   1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.8 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413
SECTION 22 34 36 - ELECTRIC DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following electric water heaters:

1. Light-commercial electric water heaters.
2. Compression tanks.
3. Water heater accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
B. Field quality-control test reports.
C. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
D. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
D. ASME Compliance: Where indicated, fabricate and label commercial water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.
1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:
   a. Structural failures including storage tank and supports.
   b. Faulty operation of controls.
   c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Period(s): From date of Substantial Completion:
   a. Light-Commercial Electric Water Heaters:
      1) Storage Tank: Three years.
      2) Controls and Other Components: One year.
   b. Compression Tanks: One year.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

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

2.2 LIGHT-COMMERCIAL ELECTRIC WATER HEATERS

A. Description: Comply with UL 174 for household, storage electric water heaters.

1. Manufacturers:
   b. Lochinvar Corporation.
   c. Smith, A. O. Water Products Company.
   d. State Industries, Inc.
   e. Reference Section 224200 for additional alternate manufacturers.

2. Storage-Tank Construction: Steel, vertical arrangement.
   b. Pressure Rating: 150 psig.
   c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.

3. Factory-Installed Storage-Tank Appurtenances:
a. Anode Rod: Replaceable magnesium.
b. Dip Tube: Provide unless cold-water inlet is near bottom of tank.
c. Drain Valve: ASSE 1005.
d. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
e. Jacket: Steel with enameled finish.
f. Heat Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation, unless otherwise indicated.
h. Temperature Control: Adjustable thermostat for each element.
i. Safety Control: High-temperature-limit cutoff device or system.
j. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.

2.3 COMPRESSION TANKS

A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.

1. Manufacturers:
   a. AMTROL Inc.
   b. Armstrong Pumps, Inc.
   c. Flexcon Industries.
   d. Honeywell Sparco.
   e. Myers, F. E.; Pentair Pump Group (The).
   f. Smith, A. O.; Aqua-Air Div.
   g. State Industries, Inc.
   h. Taco, Inc.
   i. Watts Regulator Co.
   j. Wessels Co.

2. Construction:
   a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
   b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
   c. Air-Charging Valve: Factory installed.

2.4 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than water heater working-pressure rating.
C. Water Heater Stand and Drain-Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 drain outlet with ASME B1.20.1 pipe thread.

D. Water Heater Stands: Water heater manufacturer's factory-fabricated steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

E. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.

F. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4.

G. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that are capable of isolating each water heater and of providing balanced flow through each water heater.

H. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

I. Water Regulators: ASSE 1003, water-pressure reducing valve. Set at 25-psig maximum outlet pressure, unless otherwise indicated.

J. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

2.5 SOURCE QUALITY CONTROL

A. Test and inspect water heater storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test water heater storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

B. Install combination temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

C. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
D. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 22 Section "Plumbing Specialties" for hose-end drain valves.

E. Install thermometer on outlet piping of water heaters.

F. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Division 22 Section "Valves" for general-duty valves.

G. Install water regulator, with integral bypass relief valve, in booster-heater inlet piping and water hammer arrester in booster-heater outlet piping.

H. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

I. Fill water heaters with water.

J. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

END OF SECTION 22 34 36
SECTION 22 42 00 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes plumbing fixtures and related components.

1.3 DEFINITIONS

A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

1.4 SUBMITTALS

A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.

B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.


F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.6 COORDINATION

A. Coordinate roughing-in and final plumbing fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

PART 2 - PRODUCTS

2.1 PLUMBING FIXTURES

A. For fixture descriptions refer to schedule on drawings.

2.2 ALTERNATE ACCEPTABLE MANUFACTURERS

B. Sinks – Advance Tabco, Elkay, Just, Moen.
C. Water Closet Seats – Bemis, Beneke, Centoco, Church, Toto, Zurn.
D. Lavatory/Sink Accessories – Advance Tabco, BrassCraft, Chicago, Dearborn, McGuire, Zurn.
E. Undercounter Pipe Insulation Kits – Mainline, Plumberex, Truebro.
F. Flush Valves – American Standard, Delany, Delta Commercial, Moen, Sloan, Toto, Zurn.
G. Fixture Carriers – Mifab, Jay R Smith, Josam, Wade, Watts, Zurn.
J. Service Sinks – Fiat, Florestone, Mustee, Stern Williams, Swan, Zurn.
L. Expansion Tanks – Mainline, Watts, Wessels.
M. Wall Faucets - Acorn, Jay R Smith, Josam, Mifab, Wade, Watts, Woodford, Zurn.
O. Trap Primer Valves – Josam, Mifab, PPP, Sioux Chief, Zurn.
Q. Backflow Preventers – Ames, Beeco,Febco, Watts, Wilkins.
R. Water Hammer Arrestors - Josam, Mifab, Sioux Chief, Wade, Watts, Zurn.
S. Cleanouts - Josam, Mifab, Sioux Chief, Wade, Watts, Zurn.
T. Icemaker Outlet Box – Guy Gray, Oatey, Water-Tite.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation. Use manufacturer's roughing-in data where roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

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

3.2 FIXTURE INSTALLATION

A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. For wall-hanging fixtures, install off-floor supports affixed to building substrate.
   1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
   2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
   3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-hanging fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-hanging fixtures with tubular waste piping attached to supports.

F. Install counter-mounting fixtures in and attached to casework.

G. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.

H. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
   1. Exception: Use ball, gate, or globe valve if stops are not specified with fixture. Refer to Division 22 Section "Valves" for general-duty valves.

I. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

J. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

K. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

L. Install toilet seats on water closets.
M. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

N. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

O. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

P. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

Q. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for escutcheons.

R. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 and 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect water supplies from water distribution piping to fixtures.

C. Connect drain piping from fixtures to drainage piping.

D. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

E. Ground equipment.
   1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.
3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at faucets, and flush valves to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers’ recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION 22 42 00
SECTION 23 00 00 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

1. The mechanical portion of this project includes all labor, materials, equipment, etc., required to provide the complete mechanical work to fulfill the intent of the Contract Documents.

1.2 RELATED DOCUMENTS

1. All applicable provisions of Division 0 and 1 govern work under this division. Refer to these articles in the specifications for additional information.

2. All work shall be in compliance with the currently enforced edition of the applicable state, national, and local ordinance and building codes. No additional compensation shall be granted for work which must be changed as a result of the work not originally complying with the codes and standards, etc.

3. Refer to each section for additional applicable codes and reference standards.

1.3 FEES, PERMITS AND TAXES

1. This Contractor is responsible for all inspection fees and permits required by local authorities having jurisdiction. The Contractor is also responsible for all taxes levied for labor and materials associated with the mechanical portion of the work. After completion of the work, a certificate of final inspection shall be provided showing approval from the local Inspector.

1.4 SUBMITTALS

1. Submittals shall be provided for all equipment, fixtures and other items indicated. Product data shall be from published manufacturer’s data. Data shall include enough information so that the Engineer can verify compliance with codes, standards, and the contract documents. Submittal shall not contain data that is not relevant to the equipment being submitted. The data shall be highlighted by arrows, underlining, etc. Broad, general data, is not acceptable. Data shall be presented at one time, in a neatly bound and organized manner.

2. Submit a single electronic copy or a minimum of 5 copies of each required submittal. Electronic submittals shall be divided by individual specification division and only combined where total document size is less than 100 pages. The Engineer will return the copies marked with action taken and corrections or modifications required. Unless resubmittal is requested, the submittal may serve as the final submittal.

3. The contractor shall provide and maintain at the site a set of prints which accurately represent the actual installation of all work under this Division. Any changes in sizes, locations, dimensions, etc. shall be shown.

4. At the completion of the Project, a set of marked-up drawings, including DIMENSIONED, location of all underground piping shall be provided to the owner.
1.5 OPERATING AND MAINTENANCE MANUALS AND INSTRUCTIONS

1. Operating and Maintenance Data includes printed information, such as manufacturer's installation instructions, manufacturer's service manuals, manufacturer's lubrication charts, standard wiring diagrams, and a parts list including the price of each item.

2. Mark each copy to show applicable choices and options. Where printed Operating and Maintenance Data includes information on several products that are not required, mark copies to indicate the applicable information.

3. Assemble a complete set of operation and maintenance data indicating the operation and maintenance of each system, subsystem, and piece of equipment not part of a system. Include operation and maintenance data required in individual Specification Sections and as follows:

1. Operation Data:
   1. Emergency instructions and procedures.
   2. System, subsystem, and equipment descriptions, including operating standards.
   3. Operating procedures, including startup, shutdown, seasonal, and weekend operations.
   4. Description of controls and sequence of operations.
   5. Piping and wiring diagrams.

2. Maintenance Data:
   1. Manufacturer's information, including list of spare parts.
   2. Name, address, and telephone number of Installer or supplier.
   4. Maintenance and service schedules for preventive and routine maintenance.
   5. Maintenance record forms.
   6. Sources of spare parts and maintenance materials.
   8. Copies of warranties and bonds.

4. Organize operation and maintenance manuals into suitable sets of manageable size. Bind and index data in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, with pocket inside the covers to receive folded oversized sheets. Identify each binder on front and spine with the printed title "OPERATION AND MAINTENANCE MANUAL," Project name, and subject matter of contents.

5. Do not submit Operating and Maintenance Data until compliance with requirements of the Contract Documents has been confirmed.

1.6 PRIOR APPROVAL

1. The drawings and specifications are intended to indicate a standard of quality for items by identifying manufacturer’s names and model numbers. It is the responsibility of the contractor to prove equality for any substitutions.

The contractor shall submit a list of proposed substitutions to the Engineer. All proposed substitutions shall be in writing to the Engineer, at least, ten (10) calendar days prior to bid opening. The submittal will list the proposed substitutions from published manufacturer’s data, which cover the applicable features of the submitted equipment. Any approvals shall be issued in writing.
1.7 GUARANTEE

1. The contractor shall fully guarantee the installation against defects in materials and workmanship which may occur under normal usage for a period of one year after owner's acceptance. Defects shall be promptly remedied at no cost to the owner. This guarantee is in addition to, and not a limit to, any other guarantees or warranties.

1.8 DEFINITIONS. The following words and phases are defined:

1. "Indicated": The term "indicated" refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the user locate the reference. Location is not limited.

2. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by the Architect/Engineer, requested by the Architect/Engineer, and similar phrases.

3. "Approved": The term "approved," when used in conjunction with the Architect's/Engineer’s action on the Contractor's submittals, applications, and requests, is limited to the Architect's/Engineer's duties and responsibilities as stated in the Conditions of the Contract.

4. "Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

5. "Furnish": The term "furnish" means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

6. "Install": The term "install" describes operations at the Project site including the actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

7. "Provide": The term "provide" means to furnish and install, complete and ready for the intended use.

8. "Installer": An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, or similar operations. Installers are required to be experienced in the operations they are engaged to perform.

9. "Project site" is the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

10. "Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.
1.9 INSPECTION OF THE SITE

1. The drawings are prepared from the most accurate information available. However, in order to insure responsible bidding by the contractor, he shall, prior to placing any bids, visit the site to verify existing conditions, the locations, sizes, depths, pressures, etc., of all existing utilities and become familiar with working conditions, hazards, existing grades, obstructions, local requirements involved, etc.

2. All proposals shall take these existing conditions and any speculated revisions needed into account. The contractor shall be fully responsible for his bid regardless of any additional site information which may be uncovered after a contract is signed.

1.10 CONSTRUCTION SAFETY

1. The plans and specifications do not include items necessary for the contractor to insure the safety of his personnel on the project construction site. Construction site safety for the project is the responsibility of the contractor. Reference other sections of these specifications for any additional information.

1.11 DAMAGE

1. The contractor shall be held accountable to repair, at no cost to the owner, any damage to existing wiring, piping, or other materials and equipment intended to remain.

2. The contractor shall be held accountable to repair, at no cost to the owner, any damage to project due to failure to recognize associated hazards such as leaks, scheduling of work, poor workmanship, excessive cutting, etc.

1.12 DRAWINGS AND SPECIFICATIONS

1. Should be considered as complimentary to each other. What is required by one shall be binding as if required by both. If conflicts between plans and specifications are found, the Engineer shall be contacted to secure clarification, prior to bidding. The contractor shall verify all dimensions and existing conditions.

PART 2 - EXECUTION

2.1 WORKMANSHIP

1. All work shall be done in a professional and complete manner by experienced craftsmen. Unsatisfactory workmanship shall be duly noted and corrected at the contractor’s expense.

2. Only new materials shall be used, unless otherwise indicated on plan or prior approved.

2.2 MANUFACTURER’S INSTALLATION INSTRUCTIONS

1. All equipment shall be installed in accordance with manufacturer’s installation instructions.
2.3 PROTECTION OF EQUIPMENT

1. The contractor shall provide protection of stored material and installed equipment against dirt, rust, moisture, and abuse from other trades. Where tarps or other cover is used, provide air circulation to prevent condensate build up. No materials or equipment shall be stored directly on the ground. Ductwork, piping and equipment are prohibited from use as scaffolding or personnel supports.

2. Upon completion of work, all equipment, fixtures, piping, etc., shall be cleaned to the satisfaction of the Architect. All repairs due to damage shall be at the Contractor’s expense.

2.4 CONFLICTS, INTERFERENCES AND COORDINATION BETWEEN TRADES

1. Coordinate work so as to conform with the progress of the work of others. The drawings are only intended to indicate the extent, general location and arrangement, of piping systems, ductwork and equipment. The drawings are not to be construed as shop drawings. Any questions regarding the information given on the plans shall be directed to the Engineer for clarification. The contractor shall refer to other sections of the specifications and other drawings such as structural, electrical, etc., in order to eliminate conflicts when laying out his work. The contractor shall be responsible for the proper coordination of the mechanical work with the installations under other Divisions for clearances, etc. Any changes required to avoid interferences shall be submitted to the Architect for approval and shall be made, as approved, without additional cost to the Owner.

2. Code requirements shall have precedence over plans or specifications in the event of a conflict. If a discrepancy or conflict exists between specifications and drawings, drawings shall take precedence over specifications except as pertaining to quality. Manufacturer’s installation instructions shall govern the installation of all equipment.

3. The contractor shall coordinate with equipment suppliers for any requirements specific to the equipment provided which may not be shown on the plans or given in the specifications. The contractor shall include the provision and installation of such requirements in his bid. The contractor shall coordinate with equipment suppliers, prior to bid, to determine what ancillary equipment is or is not provided with the equipment, such as bolts, gaskets, oils, drive belts, etc. Coordinate with Owner for owner supplied equipment.

4. Equipment requiring set grades or elevations and piping has precedence over ductwork, conduit, boxes, etc. as to location.

5. The contractor shall coordinate with other equipment providers to insure correct operation of the equipment, such as, phase rotation, interlocking, accessibility, etc.

6. The contractor shall examine the Architectural plans for the location of suitable openings and aisles for the passage of equipment to be installed under this Division. The contractor shall be responsible for having suitable openings and aisles left open until his equipment has been properly installed.

7. Except as otherwise noted, it shall be understood that the indication and/or description of any item, in the drawings or specifications, or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

8. The right is reserved to make reasonable changes in locations of equipment indicated in Drawings prior to installation without an increase in the contract cost.

9. The drawings and specifications do not undertake to indicate every item required to produce a complete and properly operational installation. Material, equipment or labor not indicated, but which can be reasonably inferred to be necessary for a complete installation shall be provided.
2.5 CUTTING AND PATCHING

1. Every effort shall be made to build-in the work as the job progresses. As required, cutting and patching for the installation of sleeves, piping, equipment, etc., shall be coordinated with the General Contractor. Do not cut any structural element without written permission from the Structural Engineer.

2.6 EQUIPMENT CONNECTIONS

1. The contractor shall make final connection of all required services to all equipment items furnished, including that provided by others or by the owner. Equipment shall be left in a ready to operate condition.

2.7 FLASHING AND WATERPROOFING

1. All building penetrations to the outside shall be flashed and sealed, as required, to prevent leaks.

2.8 DEMONSTRATION:

1. Engage a factory authorized service representative to train Owner's maintenance personnel to operate all mechanical systems.

END OF SECTION 23 00 00
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 22 and 23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Escutcheons.
3. Dielectric fittings.
4. Flexible connectors.
5. Mechanical sleeve seals.
6. Equipment nameplate data requirements.
7. Labeling and identifying mechanical systems and equipment.
8. Nonshrink grout for equipment installations.
9. Installation requirements common to equipment specification sections.
10. Cutting and patching.
11. Touchup painting and finishing.

B. Pipe and pipe fitting materials are specified in Division 21 through 23 piping system Sections.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
1.4 SUBMITTALS

A. Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.

B. Coordination Drawings: Detail major elements, components, and systems of mechanical equipment rooms in relationship with other systems, installations, and building components. Show space requirements for installation and access. Indicate if sequence and coordination of installations are important to efficient flow of the Work. Include the following:

1. Planned piping layout, including valve and specialty locations and valve-stem movement.
2. Required clearances for installing, servicing and maintaining equipment, insulation, accessories, and specialties, including space for disassembly required for periodic maintenance.
3. Equipment and accessory service connections and support details.
4. Exterior wall and foundation penetrations.
5. Fire-rated wall and floor penetrations.
6. Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

1.5 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

B. Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be incorporated into contract price. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

C. Protect flanges, fittings, and piping specialties from moisture and dirt.

D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 SEQUENCING AND SCHEDULING

A. Coordinate mechanical equipment installation with other building components.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.

G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. STEEL PIPING

1. Steel Pipe: ASTM A 53, Type E or S, Grade A or B, Schedule 40, galvanized. Include ends matching joining method.


7. Grooved-End Fittings: ASTM A 47, malleable-iron casting; ASTM A 106, galvanized, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

8. Expansion Joints: Compound, galvanized, steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

9. Double Expansion Joints: Compound, galvanized, steel fitting with telescoping body and two slip-pipe sections. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

10. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

B. DUCTILE-IRON PIPING

1. Piping for fire-suppression applications shall be listed for fire-protection service.

2. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint, bell- and plain-spigot end, unless grooved or flanged ends are indicated.

3. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint, bell- and plain-spigot end, unless grooved or flanged ends are indicated.

4. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron, standard pattern; or AWWA C153, ductile-iron, compact pattern.
a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

5. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron, standard pattern; or AWWA C153, ductile-iron, compact pattern.


a. Ductile-Iron-Piping, Keyed Couplings: AWWA C606, for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

7. Flexible Expansion Joints: Compound, ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include two gasketed, ball-joint sections and one or more gasketed, sleeve section. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

8. Deflection Fittings: Compound, ductile-iron coupling fitting with sleeve and flexing sections for up to 20-degree deflection, gaskets, and restrained-joint ends complying with AWWA C110 or AWWA C153. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.


C. COPPER TUBING AND FITTINGS

1. DWV Copper Tube: ASTM B 306, drainage tube, drawn temper.
2. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
3. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
7. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
8. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.
9. Copper-Tubing, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

D. CAST-IRON SOIL PIPING AND FITTINGS

2. Hubless Pipe and Fittings: ASTM A 888 or CISPI 301.
5. Heavy-Duty, Type 304, Stainless-Steel Couplings: ASTM A 666, Type 304, stainless-steel shield; stainless-steel bands; and sleeve.

a. NPS 1-1/2 to NPS 4: 3-inch-wide shield with 4 bands.
6. Compact, Stainless-Steel Couplings: CISPI 310 with ASTM A 167, Type 301, or ASTM A 666, Type 301, stainless-steel corrugated shield; stainless-steel bands; and sleeve.
   a. NPS 1-1/2 to NPS 4: 2-1/8-inch-wide shield with 2 bands.

2.2 JOINING MATERIALS

A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32.
   1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
   2. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.

E. Brazing Filler Metals: AWS A5.8.
   1. BAg1: Silver alloy.

F. Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.


2.3 DIELECTRIC FITTINGS

A. General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

B. Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

C. Insulating Material: Suitable for system fluid, pressure, and temperature.
2.4 FLEXIBLE CONNECTORS

A. General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

1. 2-Inch NPS and Smaller: Threaded.
2. 2-1/2-Inch NPS and Larger: Flanged.

B. Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

C. Rubber, Flexible Connectors: CR or EPDM elastomer rubber construction, with multiple plies of NP fabric, molded and cured in hydraulic presses. Include 125-psig minimum working-pressure rating at 220 deg F. Units may be straight or elbow type, unless otherwise indicated.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

2.6 PIPING SPECIALTIES

A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast Iron: Cast or fabricated “wall pipe” equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   a. Underdeck Clamp: Clamping ring with set screws.

5. PVC Pipe: ASTM D 1785, Schedule 40.

B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.

1. ID: Closely fit around pipe, tube, and insulation of insulated piping.
2. OD: Completely cover opening.
3. Cast Brass: One piece, with set screw.


5. Cast-Iron Floor Plate: One-piece casting.
2.7 IDENTIFYING DEVICES AND LABELS

A. General: Manufacturer's standard products of categories and types required for each application as referenced in other Division 22 and 23 Sections. If more than one type is specified for application, selection is installer's option, but provide one selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped; permanently fastened to equipment.
   1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
   2. Location: Accessible and visible location.

2.8 GROUT

A. Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.
   2. Design Mix: 5000-psig, 28-day compressive strength.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 22 piping Sections specify unique piping installation requirements.

B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved by the Engineer in writing.

C. Install piping at slope indicated on plan, in these specifications, or as required by governing codes.

D. Install components with pressure rating equal to or greater than system operating pressure.

E. Install piping in concealed locations, except in equipment rooms and service areas.

F. Install piping free of sags and bends. Decrease hanger spacing if required.

G. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

I. Install piping to allow application of insulation plus 1-inch clearance around insulation.

J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.

K. Install fittings for changes in direction and branch connections.
L. Install couplings according to manufacturer's written instructions.

M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:
   1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
   2. Uninsulated Piping Wall Escutcheons: Cast brass, with set screw.
   3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
   4. Insulated Piping: Cast brass; with concealed hinge, spring clips, and chrome-plated finish.
   5. Piping in Utility Areas: Cast brass, with set-screw or spring clips.

N. Sleeves are not required for core drilled holes.

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Build sleeves into new walls and slabs as work progresses.
   3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
      b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
         1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
   4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants.
   5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.

P. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter.


R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping materials.

S. Verify final equipment locations for roughing-in.

T. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
5. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   a. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
   b. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

U. Piping Connections: Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping 2-inch NPS and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS or smaller threaded pipe connection.
2. Install flanges, in piping 2-1/2-inch NPS and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Engineer.
C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
E. Install equipment giving right of way to piping installed at required slope.
F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.
3.3 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.
   2. Locate pipe markers as follows if piping is exposed in finished spaces, machine rooms, and accessible maintenance spaces, such as shafts, tunnels, plenums, and exterior nonconcealed locations:
      a. Near each valve and control device.
      b. Near each branch, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, if flow pattern is not obvious.
      c. Near locations if pipes pass through walls, floors, ceilings, or enter nonaccessible enclosures.
      d. At access doors, manholes, and similar access points that permit view of concealed piping.
      e. Near major equipment items and other points of origination and termination.
      f. Spaced at maximum of 25-foot intervals along each run. Reduce intervals to 15 feet in congested areas of piping and equipment.
      g. Pipe Identification:
         1) Domestic Water: Grey.

B. Equipment: Install equipment marker on or near each major item of mechanical equipment.
   1. Stenciled Markers: According to ASME A13.1
   2. Lettering Size: Minimum 1-inch-high lettering for name of unit if viewing distance is less than 24 inches, 2-inch-high lettering for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
   3. Text of Signs: Provide name of identified unit to match name of unit indicated on plan. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with stenciled signs and arrows, showing duct system service and direction of flow.
   1. Location: In each space, if ducts are exposed or concealed by removable ceiling system, locate signs near points where ducts enter into space and at maximum intervals of 25 feet.

3.4 PAINTING AND FINISHING

A. Refer to Section "Painting" for paint materials, surface preparation, and application of paint.

B. Apply paint to exposed piping according to the following, unless otherwise indicated:
   1. Interior, Piping and Supports: Use semi-gloss, acrylic-enamel finish. Include finish coat over enamel undercoat and primer. Color to match adjacent finish or as directed and approved by architect.
   2. Exterior, Piping and Supports: Use semi-gloss, acrylic-enamel finish. Include two finish coats over primer; rust-inhibitive metal primer for ferrous piping applications. Color to match adjacent finish or as directed and approved by architect.
a. Primer shall be a different color than undercoat and undercoat shall be a different color than the finish coat.
b. Allow sufficient time for each coat to fully dry prior to applying the next coat.

C. Do not paint piping specialties with factory-applied finish.

D. Damage and Touch-up: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.5 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

B. Repair cut surfaces to match adjacent surfaces.

3.6 GROUTING

A. Install nonmetallic, non-shrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placing of grout.

E. Place grout, completely filling equipment bases.

F. Place grout around anchors.

G. Cure placed grout according to manufacturer's written instructions.

END OF SECTION 23 05 00
SECTION 23 05 29 - HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following hangers and supports for mechanical system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.

B. Related Sections include the following:
   1. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for “The Valve and Fittings Industry Inc.”.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Thermal-hanger shield inserts.
   3. Powder-actuated fastener systems.
PART 2 - PRODUCTS

2.1 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:

1. AAA Technology & Specialties Co., Inc.
2. Bergen-Power Pipe Supports.
4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co.
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.2 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.3 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:

2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
3. GS Metals Corp.
5. Thomas & Betts Corporation.
6. Tolco Inc.
7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

   1. Manufacturers:
      b. Empire Industries, Inc.
      c. Hilti, Inc.
      d. ITW Ramset/Red Head.
      e. MKT Fastening, LLC.
      f. Powers Fasteners.
2.6 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
   6. Adjustable Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
   7. Adjustable Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
   8. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
   9. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
  10. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
11. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
12. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
13. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
14. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
15. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
16. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
17. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
18. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
19. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 lb (340 kg).
   b. Medium (MSS Type 32): 1500 lb (680 kg).
   c. Heavy (MSS Type 33): 3000 lb (1360 kg).
13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
a. Horizontal (MSS Type 54): Mounted horizontally.
b. Vertical (MSS Type 55): Mounted vertically.
c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:

1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer’s written instructions.

F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

H. Install lateral bracing with pipe hangers and supports to prevent swaying.

I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
J. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

L. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

4. Shield Dimensions for Pipe: Not less than the following:
   a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

5. Insert Material: Length at least as long as protective shield.

6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.

B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.

C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 9 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 23 05 29
PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes the following mechanical identification materials and their installation:
   1. Equipment nameplates.
   2. Access panel and door markers.
   3. Pipe markers.
   4. Duct markers.

1.3 QUALITY ASSURANCE

1.4 COORDINATION
A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with location of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT IDENTIFICATION DEVICES
A. Equipment Nameplates: Metal, with data engraved or stamped, for permanent attachment on equipment.
   1. Data:
      a. Manufacturer, product name, model number, and serial number.
      b. Capacity, operating and power characteristics, and essential data.
      c. Labels of tested compliances.
   2. Location: Accessible and visible.
3. Fasteners: As required to mount on equipment.

B. Access Panel and Door Markers: 1/16-inch thick, engraved laminated plastic, with abbreviated terms and numbers corresponding to identification. Provide 1/8-inch center hole for attachment.

1. Fasteners: Self-tapping, stainless-steel screws or contact-type, permanent adhesive.

2.2 PIPING IDENTIFICATION DEVICES

A. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing direction of flow.

1. Colors: Comply with ASME A13.1, unless otherwise indicated.
2. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.
3. Pipes with OD, Including Insulation, less than 6 inches: Full-band pipe markers extending 360 degrees around pipe at each location.
4. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

B. Pretensioned Pipe Markers: Precoiled semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without adhesive.

C. Shaped Pipe Markers: Preformed semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe with mechanical fasteners that do not penetrate insulation vapor barrier.


E. Plastic Tape: Continuously printed, vinyl tape at least 3 mils thick with pressure-sensitive, permanent-type, self-adhesive back.

1. Width for Markers on Pipes with OD, Including Insulation, less than 6 inches: 3/4 inch minimum.

2.3 DUCT IDENTIFICATION DEVICES

A. Duct Markers: Engraved, color-coded laminated plastic. Include direction and quantity of airflow and duct service (such as supply, return, and exhaust). Include contact-type, permanent adhesive.

PART 3 - EXECUTION

3.1 APPLICATIONS, GENERAL

A. Products specified are for applications referenced in other Division 22 and 23 Sections. If more than single-type material, device, or label is specified for listed applications, selection is Installer’s option.
3.2 EQUIPMENT IDENTIFICATION

A. Install and permanently fasten equipment nameplates on each major item of mechanical equipment that does not have nameplate or has nameplate that is damaged or located where not easily visible. Locate nameplates where accessible and visible. Include nameplates for the following general categories of equipment:

1. Fans.
2. Packaged HVAC central-station and zone-type units.

B. Install access panel markers with screws on equipment access panels.

3.3 PIPING IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system. Install with flow indication arrows showing direction of flow.

1. Pipes with OD, Including Insulation, less than 6 inches: Pretensioned pipe markers. Use size to ensure a tight fit.
2. Pipes with OD, Including Insulation, less than 6 inches: Self-adhesive pipe markers. Use color-coded, self-adhesive plastic tape, at least 3/4 inch wide, lapped at least 1-1/2 inches at both ends of pipe marker, and covering full circumference of pipe.

B. Locate pipe markers and color bands where piping is exposed in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.

3.4 DUCT IDENTIFICATION

A. Install duct markers with permanent adhesive on air ducts in the following color codes:

1. Green: For supply ducts.
2. Blue: For exhaust-, outside-, return-, and mixed-air ducts.
3. ASME A13.1 Colors and Designs: For hazardous material exhaust.
4. Letter Size: Minimum 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

B. Locate markers near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.
3.5 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.6 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION 23 05 53
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:

1. Air Systems:
   a. Constant-volume air systems.

2. HVAC equipment quantitative-performance settings.
3. Verifying that automatic control devices are functioning properly.
4. Reporting results of activities and procedures specified in this Section.

1.3 DEFINITIONS

A. Adjust: To regulate air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

F. RC: Room criteria.

G. Report Forms: Test data sheets for recording test data in logical order.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
J. TAB: Testing, adjusting, and balancing.

K. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

L. Test: A procedure to determine quantitative performance of systems or equipment.

M. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 45 days from Contractor's Notice to Proceed, submit 6 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

C. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by NEBB.

B. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.


D. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

E. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
2. Verify that balancing devices, such as test ports, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 1 Section "Project Record Documents."

D. Examine design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

E. Examine equipment performance data including fan curves. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.
F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine plenum ceilings used for supply air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

L. Examine equipment for installation and for properly operating safety interlocks and controls.

M. Examine automatic temperature system components to verify the following:

1. Dampers and other controlled devices are operated by the intended controller.
2. Dampers are in the position indicated by the controller.
3. Integrity of dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at indicated values.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs according to indicated values.

N. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Cut insulation, ducts and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, to show final settings.
D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.3 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

C. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

D. Verify that motor starters are equipped with properly sized thermal protection.

E. Check dampers for proper position to achieve desired airflow path.

F. Check for airflow blockages.

G. Check condensate drains for proper connections and functioning.

H. Check for proper sealing of air-handling unit components.

I. Check for proper sealing of air duct system.

3.4 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:
   a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
   b. Measure static pressure directly at the fan outlet or through the flexible connection.
   c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
   d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers, under final balanced conditions.

4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Obtain approval from Architect for adjustment of fan speed higher or lower than indicated speed. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.

6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full cooling, full heating, economizer, and any other operating modes to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
   
a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.5 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.6 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.
C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators.

F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.7 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Minus 5 to plus 10 percent.
2. Air Outlets and Inlets: Plus 5 or minus 5 percent.

3.8 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of instruments used for procedures, along with proof of calibration.

C. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of TAB firm.
3. Project name.
4. Project location.
5. Contractor's name and address.
7. Signature of TAB firm who certifies the report.
8. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
9. Summary of contents including the following:

   a. Indicated versus final performance.
   b. Notable characteristics of systems.
c. Description of system operation sequence if it varies from the Contract Documents.

10. Nomenclature sheets for each item of equipment.
11. Data for terminal units, including manufacturer, type size, and fittings.
12. Notes to explain why certain final data in the body of reports varies from indicated values.
13. Test conditions for fans and pump performance forms including the following:
   a. Settings for outside-, return-, and exhaust-air dampers.
   b. Conditions of filters.
   c. Cooling coil, wet- and dry-bulb conditions.
   d. Fan drive settings including settings and percentage of maximum pitch diameter.
   e. Settings for supply-air, static-pressure controller.
   f. Other system operating conditions that affect performance.

D. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

   1. Unit Data: Include the following:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.
      f. Unit arrangement and class.
      g. Discharge arrangement.
      h. Sheave make, size in inches (mm), and bore.
      i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
      j. Number of belts, make, and size.
      k. Number of filters, type, and size.

   2. Motor Data:
      a. Make and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches (mm), and bore.
      f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm (L/s).
      b. Total system static pressure in inches wg (Pa).
      c. Fan rpm.
      d. Discharge static pressure in inches wg (Pa).
      e. Filter static-pressure differential in inches wg (Pa).
      f. Outside airflow in cfm (L/s).
      g. Return airflow in cfm (L/s).

E. Fan Test Reports: For exhaust fans, include the following:

   1. Fan Data:
      a. System identification.
b. Location.
c. Make and type.
d. Model number and size.
e. Manufacturer's serial number.
f. Arrangement and class.
g. Sheave make, size in inches (mm), and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).

2. Motor Data:
   a. Make and frame type and size.
   b. Horsepower and rpm.
   c. Volts, phase, and hertz.
   d. Full-load amperage and service factor.
   e. Sheave make, size in inches (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
   g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Suction static pressure in inches wg (Pa).

3.9 INSPECTIONS

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the Final Report.
   2. Randomly check the following for each system:
      a. Measure airflow of at least 10 percent of air outlets.
      b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      c. Verify that balancing devices are marked with final balance position.

B. Final Inspection:
   1. After initial inspection is complete and evidence by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Architect.
   2. Architect shall randomly select measurements documented in the final report to be rechecked. The rechecking shall be limited to either 10 percent of the total measurements recorded, or the extent of measurements that can be accomplished in a normal 8-hour business day.
   3. If the rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
4. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

5. TAB firm shall recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes and resubmit the final report.

6. Request a second final inspection. If the second final inspection also fails, Owner shall contract the services of another TAB firm to complete the testing and balancing in accordance with the Contract Documents and deduct the cost of the services from the final payment.

END OF SECTION 23 05 93
SECTION 23 07 13 - DUCT INSULATION

PART 1 - GENERAL

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

1.2 SUMMARY
A. This Section includes semi-rigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.
B. Related Sections include the following:
   1. Division 22 Section "Pipe Insulation" for insulation for piping systems.
   2. Division 23 Section "Metal Ducts" for duct liner.

1.3 SUBMITTALS
A. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.
B. Shop Drawings: Show fabrication and installation details for the following:
   1. Removable insulation sections at access panels.
   2. Application of field-applied jackets.
   3. Applications at linkages for control devices.

1.4 QUALITY ASSURANCE
A. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.
   1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING
A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.
1.6 COORDINATION

A. Coordinate clearance requirements with duct installer for insulation application.

1.7 SCHEDULING

A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Mineral-Fiber Insulation:
   a. CertainTeed Manson.
   b. Knauf FiberGlass GmbH.
   c. Owens-Corning Fiberglas Corp.
   d. Schuller International, Inc.

2. Flexible Elastomeric Thermal Insulation:
   a. Armstrong World Industries, Inc.
   b. Rubatex Corp.

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

C. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.

   1. Adhesive: As recommended by insulation material manufacturer.
   2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.
   1. Adhesive: As recommended by insulation material manufacturer.
   2. PVC Jacket Color: White or gray.
   3. PVC Jacket Color: Custom color selected by the architect.

D. Aluminum Jacket: Deep corrugated sheets manufactured from aluminum alloy complying with ASTM B 209, and having an integrally bonded moisture barrier over entire surface in contact with insulation. Metal thickness and corrugation dimensions are scheduled at the end of this Section.
   1. Finish: Smooth finish.
   2. Finish: Cross-crimp corrugated finish.
   3. Finish: Stucco-embossed finish.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd..
   1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:
   1. Stainless Steel: ASTM A 666, Type 304; 0.020 inch thick.
   2. Galvanized Steel: 0.005 inch thick.
   3. Aluminum: 0.007 inch thick.
   4. Brass: 0.010 inch thick.
   5. Nickel-Copper Alloy: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.
   1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
   1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

F. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.
2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer’s written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.
K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:
   1. Pull jacket tight and smooth.
   2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
   3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation according to manufacturer’s written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.
   1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
   2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer’s recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
   2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
   3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
      b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
      c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not over compress insulation during installation.
   4. Impale insulation over anchors and attach speed washers.
   5. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
6. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.

8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.

10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.

2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Space anchor pins as follows:
   a. On duct sides with dimensions 18 inches and smaller, along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
   b. On duct sides with dimensions larger than 18 inches. Space 16 inches o.c. each way and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
   c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.

6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

7. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch-wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.

8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to ducts and plenums as follows:

1. Follow the manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer’s recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the duct and plenum surface.

3.6 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.
   1. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
   2. Embed glass cloth between two 0.062-inch-thick coats of jacket manufacturer’s recommended adhesive.
   3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.7 FINISHES

A. Glass-Cloth Jacketed Insulation: Paint insulation finished with glass-cloth jacket as specified in Section “Painting.”

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

3.8 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

C. Insulate the following plenums and duct systems:
   1. Indoor concealed supply-, return-, and exhaust-air ductwork.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner.
   3. Factory-insulated flexible ducts.
   4. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
   5. Flexible connectors.
   7. Testing agency labels and stamps.
   8. Nameplates and data plates.
3.9 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Rectangular/round, air ducts, concealed.

2. Thickness: 3 inches.
3. Thermal Resistance Rating: R-8, installed (minimum)
4. Number of Layers: One.
6. Vapor Retarder Required: Yes.

END OF SECTION 23 07 13
SECTION 23 23 00 - REFRIGERANT PIPING

PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes refrigerant piping used for split system air conditioning unit applications.

1.3 SUBMITTALS
   A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for thermostatic expansion valves, solenoid valves, and pressure-regulating valves.
   B. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
   C. Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE
   B. ASME Standard: Comply with ASME B31.5, "Refrigeration Piping."
   C. UL Standard: Provide products complying with UL 207, "Refrigerant-Containing Components and Accessories, Nonelectrical"; or UL 429, "Electrically Operated Valves."

1.5 COORDINATION
   A. Coordinate layout and installation of refrigerant piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
   B. Coordinate pipe sleeve installations for penetrations in exterior walls and floor assemblies. Coordinate with requirements for fire-stopping for materials and methods for sealing pipe penetrations through fire and smoke barriers.
   C. Coordinate pipe fitting pressure classes with products specified in related sections.

PART 2 - PRODUCTS

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

1. Refrigerant Valves and Specialties:
   a. Sporlan Valve Company.

2.2 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tube: ASTM B 88, Type L.
B. Annealed-Temper Copper Tube: ASTM B 88, Type L.
C. Wrought-Copper Fittings: ASME B16.22.
D. Wrought-Copper Unions: ASME B16.22.
E. Bronze Filler Metals: AWS A5.8, Classification BAg-1 (silver) or BAg-2 (silver)

2.3 VALVES

A. Service Valves: 500-psig pressure rating; forged-brass body with copper stubs, brass caps, removable valve core, integral ball check valve, and with solder-end connections.
B. Thermostatic Expansion Valves: Comply with ARI 750; brass body with stainless-steel parts; thermostatic-adjustable, modulating type; size and operating characteristics as recommended by manufacturer of evaporator, and factory set for superheat requirements; solder-end connections; with sensing bulb, distributor having side connection for hot-gas bypass line, and external equalizer line.

2.4 REFRIGERANT PIPING SPECIALITIES

A. Straight- or Angle-Type Strainers: 500-psig working pressure; forged-brass or steel body with stainless-steel wire or brass-reinforced Monel screen of 80 to 100 mesh in liquid lines up to 1-1/8 inches, 60 mesh in larger liquid lines, and 40 mesh in suction lines; with screwed cleanout plug and solder-end connections.
B. Moisture/Liquid Indicators: 500-psig maximum working pressure and 200 deg F operating temperature; all-brass body with replaceable, polished, optical viewing window with color-coded moisture indicator; with solder-end connections.
C. Replaceable-Core Filter-Dryers: 500-psig maximum working pressure; heavy gage protected with corrosion-resistant-painted steel shell, flanged ring and spring, ductile-iron cover plate with steel cap screws; wrought-copper fittings for solder-end connections; with replaceable-core kit, including gaskets and the following:
   1. Filter Cartridge: Manufacturer’s standard.
D. Permanent Filter-Dryer: 350-psig maximum operating pressure and 225 deg F maximum operating temperature; steel shell and wrought-copper fittings for solder-end connections; molded-felt core surrounded by desiccant.
E. Mufflers: 500-psig operating pressure, welded-steel construction with fusible plug; sized for refrigeration capacity.

2.5 RECEIVERS
A. Receivers: ARI 495, UL listed, steel, brazed, 400-psig pressure rating, with tappings for inlet, outlet, and pressure relief valve.

2.6 REFRIGERANTS
A. ASHRAE 34, R-410a: Dichlorotrifluoroethane.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS
A. Aboveground, within Building: Type L drawn-copper tubing.

3.2 PIPING INSTALLATION
A. Install refrigerant piping according to ASHRAE 15.
B. Basic piping installation requirements are specified in Division 23 Section "Basic Mechanical Materials and Methods."
C. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
D. Arrange piping to allow inspection and service of compressor and other equipment. Install valves and specialties in accessible locations to allow for service and inspection.
E. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation. Use sleeves through floors, walls, or ceilings, sized to permit installation of full-thickness insulation.
F. Below ground, install copper tubing in protective conduit. Vent conduit outdoors.
G. Install copper tubing in rigid or flexible conduit in locations where copper tubing will be exposed to mechanical injury.
H. Slope refrigerant piping as follows:
   1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps and double risers to entrain oil in vertical runs.
   4. Liquid lines may be installed level.
I. Install bypass around moisture-liquid indicators in lines larger than NPS 2.
J. Install unions to allow removal of solenoid valves, pressure-regulating valves, and expansion valves and at connections to compressors and evaporators.
K. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

L. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports."

M. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
   2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
   3. Pipe rollers for multiple horizontal runs 20 feet or longer, supported by a trapeze.
   4. Spring hangers to support vertical runs.

N. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
   1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
   3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

O. Support vertical runs at each floor.

3.3 PIPE JOINT CONSTRUCTION

A. Braze joints according to Division 23 Section "Basic Mechanical Materials and Methods."

B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide) during brazing to prevent scale formation.

3.4 FIELD QUALITY CONTROL

A. Test and inspect refrigerant piping according to ASME B31.5, Chapter VI.
   1. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure.
   2. Test high- and low-pressure side piping of each system at not less than the lower of the design pressure or the setting of pressure relief device protecting high and low side of system.
      a. System shall maintain test pressure at the manifold gage throughout duration of test.
      b. Test joints and fittings by brushing a small amount of soap and glycerine solution over joint.
      c. Fill system with nitrogen to raise a test pressure of 150 psig or higher as required by authorities having jurisdiction.
      d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

3.5 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat requirements.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
C. Adjust set-point temperature of the conditioned air or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
   1. Check compressor oil level above center of sight glass.
   2. Open compressor suction and discharge valves.
   3. Open refrigerant valves, except bypass valves that are used for other purposes.

3.6 CLEANING
   A. Before installing copper tubing, clean tubing and fittings with trichloroethylene.
   B. Replace core of filter-dryer after system has been adjusted and design flow rates and pressures are established.

3.7 SYSTEM CHARGING
   A. Charge system using the following procedures:
      1. Install core in filter-dryer after leak test but before evacuation.
      2. Evacuate entire refrigerant system with a vacuum pump to a vacuum of 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
      3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
      4. Charge system with a new filter-dryer core in charging line. Provide full-operating charge.

END OF SECTION 23 23 00
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes from minus 2- to plus 2-inch WG. Metal ducts include the following:

1. Rectangular ducts and fittings.
2. Single-wall round spiral-seam ducts and formed fittings.
3. Double-wall round spiral-seam ducts and formed fittings.
4. Duct liner.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.4 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select size and type of air-moving and -distribution equipment and other air system components. Changes to layout or configuration of duct system must be specifically approved in writing by Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.5 QUALITY ASSURANCE

A. NFPA Compliance:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
PART 2 - PRODUCTS

2.1 PRODUCTS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

A. Fibrous-Glass Liner: Comply with NFPA 90A or NFPA 90B and with NAIMA AH124.

1. Manufacturers:
   a. CertainTeed Corp.; Insulation Group.
   c. Knauf Fiber Glass GmbH.
   d. Owens Corning.

2. Materials: ASTM C 1071; surfaces exposed to airstream shall be coated to prevent erosion of glass fibers.

   a. Thickness: 2 inch.
   b. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
   d. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.
   e. Mechanical Fasteners: Galvanized steel suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.

      1) Tensile Strength: Indefinitely sustain a 50-lb tensile, dead-load test perpendicular to duct wall.
      2) Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
      3) Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

B. Flexible Elastomeric Duct Liner: Comply with NFPA 90A or NFPA 90B.

1. Manufacturers:
a. Armstrong World Industries, Inc.

   a. Thickness: 2 inch.
   b. Thermal Conductivity (k-Value): 0.24 at 75 deg F mean temperature.
   c. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM C 411.
   d. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

2.3 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.


C. Tape Sealing System: Woven-fiber tape impregnated with gypsum mineral compound and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

D. Water-Based Joint and Seam Sealant: Flexible, adhesive sealant, resistant to UV light when cured, UL 723 listed, and complying with NFPA requirements for Class 1 ducts.

E. Solvent-Based Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant formulated with a minimum of 75 percent solids.

F. Flanged Joint Mastic: One-part, acid-curing, silicone, elastomeric joint sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

G. Flange Gaskets: Butyl rubber or EPDM polymer with polyisobutylene plasticizer.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
   2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
   1. Hangers Installed in Corrosive Atmospheres: Electro-galvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
   2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
   3. Galvanized-steel straps attached to aluminum ducts shall have contact surfaces painted with zinc-chromate primer.
C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" and complying with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.
   1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure class.
   2. Deflection: Duct systems shall not exceed deflection limits according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Transverse Joints: Prefabricated slide-on joints and components constructed using manufacturer's guidelines for material thickness, reinforcement size and spacing, and joint reinforcement.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Nexus Inc.
      c. Ward Industries, Inc.

C. Formed-On Flanges: Construct according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," Figure 1-4, using corner, bolt, cleat, and gasket details.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Lockformer.
   2. Duct Size: Maximum 30 inches wide and up to 2-inch wg pressure class.
   3. Longitudinal Seams: Pittsburgh lock sealed with noncuring polymer sealant.

D. Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches and larger and 0.0359 inch thick or less, with more than 10 sq. ft. of nonbraced panel area unless ducts are lined.

2.6 APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

B. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.
D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.

G. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

H. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
   1. Fan discharges.
   2. Intervals of lined duct preceding unlined duct.
   3. Upstream edges of transverse joints in ducts where air velocities are greater than 2500 fpm (12.7 m/s) or where indicated.

I. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell and mylar. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
   1. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.

J. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.7 ROUND DUCT AND FITTING FABRICATION

A. Round, Spiral Lock-Seam Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Duct Joints:
   1. Ducts up to 20 Inches in Diameter: Interior, center-beaded slip coupling, sealed before and after fastening, attached with sheet metal screws.
   2. Ducts 21 to 72 Inches in Diameter: Three-piece, gasketed, flanged joint consisting of two internal flanges with sealant and one external closure band with gasket.
   3. Round Ducts: Prefabricated connection system consisting of double-lipped, EPDM rubber gasket. Manufacture ducts according to connection system manufacturer's tolerances.

   a. Manufacturers:
      1) Ductmate Industries, Inc.
      2) Lindab Inc.
C. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal-seam straight ducts.

D. Diverging-Flow Fittings: Fabricate with reduced entrance to branch taps and with no excess material projecting from fitting onto branch tap entrance.

E. Fabricate elbows using die-formed, gored, pleated, or mitered construction. Bend radius of die-formed, gored, and pleated elbows shall be 1-1/2 times duct diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from minus 2- to plus 2-inch wg:
   a. Ducts 3 to 36 Inches in Diameter: 0.034 inch.
3. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from 2- to 10-inch wg:
   a. Ducts 3 to 26 Inches in Diameter: 0.034 inch.
4. 90-Degree, 2-Piece, Mitered Elbows: Use only for supply systems or for material-handling Class A or B exhaust systems and only where space restrictions do not permit using radius elbows. Fabricate with single-thickness turning vanes.
5. Round Elbows 8 Inches and Less in Diameter: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
6. Round Elbows 9 through 14 Inches in Diameter: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees unless space restrictions require mitered elbows. Fabricate nonstandard bend-angle configurations or nonstandard diameter elbows with gored construction.
7. Round Elbows Larger than 14 Inches in Diameter: Fabricate gored elbows unless space restrictions require mitered elbows.
8. Die-Formed Elbows for Sizes through 8 Inches in Diameter and All Pressures 0.040 inch thick with 2-piece welded construction.
9. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
10. Pleated Elbows for Sizes through 14 Inches in Diameter and Pressures through 10-Inch wg: 0.022 inch.

F. Manufacturers:

1. Lindab Inc.
3. SEMCO Incorporated.

G. Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner duct. Dimensions indicated are for inner ducts.

1. Outer Shell: Base metal thickness on outer-shell dimensions. Fabricate outer-shell lengths 2 inches longer than inner duct and insulation and in metal thickness specified for single-wall duct.
2. Insulation: 2-inch- thick fibrous glass, unless otherwise indicated. Terminate insulation where double-wall duct connects to single-wall duct or uninsulated components, and reduce outer shell diameter to inner duct diameter.
   a. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.

3. Solid Inner Ducts: Use the following sheet metal thicknesses and seam construction:
   a. Ducts 3 to 8 Inches in Diameter: 0.019 inch with standard spiral-seam construction.
   b. Ducts 9 to 42 Inches in Diameter: 0.019 inch with single-rib spiral-seam construction.

4. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

5. Maintain concentricity of inner duct to outer shell by mechanical means. Prevent dislocation of insulation by mechanical means.

H. Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner duct.
   1. Solid Inner Ducts: Use the following sheet metal thicknesses:
      a. Ducts 3 to 34 Inches in Diameter: 0.028 inch.
   2. Perforated Inner Ducts: Fabricate with 0.028-inch- thick sheet metal having 3/32-inch-diameter perforations, with overall open area of 23 percent.

PART 3 - EXECUTION

3.1 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
   2. Return Ducts (Negative Pressure): 2-inch wg.

B. All ducts shall be galvanized steel.

3.2 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install round ducts in lengths not less than 12 feet unless interrupted by fittings.

C. Install ducts with fewest possible joints.

D. Install fabricated fittings for changes in directions, size, and shape and for connections.
E. Install couplings tight to duct wall surface with a minimum of projections into duct. Secure couplings with sheet metal screws. Install screws at intervals of 12 inches, with a minimum of 3 screws in each coupling.

F. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

I. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

J. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

K. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

L. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire dampers, sleeves, and firestopping sealant. Fire and smoke dampers are specified in Division 23 Section "Duct Accessories." Firestopping materials and installation methods are specified in Section "Through-Penetration Firestop Systems."

O. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

P. Paint interiors of metal ducts, that do not have duct liner, for 24 inches upstream of registers and grilles. Apply one coat of flat, black, latex finish coat over a compatible galvanized-steel primer. Paint materials and application requirements are specified in painting sections.

3.3 SEAM AND JOINT SEALING

A. Seal duct seams and joints according to SMACNA’s "HVAC Duct Construction Standards--Metal and Flexible" for duct pressure class indicated.

    1. For pressure classes lower than 2-inch wg, seal transverse joints.

B. Seal ducts before external insulation is applied.
3.4 HANGING AND SUPPORTING

A. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

B. Support vertical ducts at maximum intervals of 16 feet and at each floor.

C. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

1. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

2. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Give seven days' advance notice for testing.

3. Maximum Allowable Leakage: Comply with requirements for Leakage Class 3 for round ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures). Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

END OF SECTION 23 31 13
PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Turning vanes.
5. Duct-mounting access doors.
6. Flexible connectors.
7. Flexible ducts.
8. Duct accessory hardware.

1.3 SUBMITTALS

A. Product Data: For the following:

1. Backdraft dampers.
2. Volume dampers.
3. Fire dampers.
4. Turning vanes.
5. Duct-mounting access doors.
6. Flexible connectors.
7. Flexible ducts.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Special fittings.
3. Fire-damper installations, including sleeves and duct-mounting access doors.

1.4 QUALITY ASSURANCE

1.5 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. Galvanized Sheet Steel: Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.


E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. CESCO Products.
4. Duro Dyne Corp.
5. Greenheck.
7. Prefco Products, Inc.
8. Ruskin Company.

B. Description: Multiple-blade, parallel action gravity balanced, with center-pivoted blades of maximum 6-inch width, with sealed edges, assembled in rattle-free manner with 90-degree stop, steel ball bearings, and axles; adjustment device to permit setting for varying differential static pressure.

C. Frame: 0.063-inch- thick extruded aluminum, with welded corners and mounting flange.

D. Blades: 0.025-inch- thick, roll-formed aluminum.
E. Blade Seals: Neoprene.

F. Blade Axles: Galvanized steel.

G. Tie Bars and Brackets: Aluminum.

H. Return Spring: Adjustable tension.

2.3 VOLUME DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. American Warming and Ventilating.
3. Flexmaster U.S.A., Inc.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Ruskin Company.

B. General Description: Factory fabricated, with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

1. Pressure Classes of 3-Inch wg or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.

C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.
3. Aluminum Frames: Hat-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
8. Tie Bars and Brackets: Aluminum.

D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Angle-shaped, galvanized sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch thick, galvanized sheet steel.
3. Aluminum Frames: U-shaped, 0.10-inch thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls and flangeless frames where indicated for installing in ducts.
4. Roll-Formed Aluminum Blades: 0.10-inch thick aluminum sheet.
5. Extruded-Aluminum Blades: 0.050-inch thick extruded aluminum.
7. Bearings: Stainless-steel sleeve thrust or ball.
10. Tie Bars and Brackets: Galvanized steel.

E. Jackshaft: 1-inch diameter, galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

1. Length and Number of Mountings: Appropriate to connect linkage of each damper in multiple-damper assembly.

F. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

A. Manufacturers:

1. Air Balance, Inc.
2. CESCO Products.
5. METALAIRE, Inc.
6. Nailor Industries Inc.
7. Penn Ventilation Company, Inc.
8. Prefco Products, Inc.

B. Fire dampers shall be labeled according to UL 555.

C. Fire Rating: 1-1/2 hours or as required by wall/floor rating.

D. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.

E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch thick as indicated and of length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

F. Mounting Orientation: Vertical or horizontal as indicated.

G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

I. Fusible Links: Replaceable, 165 deg F rated.

2.5 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch-wide, double-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.

1. Manufacturers:
   a. Ductmate Industries, Inc.
   b. Duro Dyne Corp.
   c. METALAIRE, Inc.
   d. Ward Industries, Inc.

C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

2.6 DUCT-MOUNTING ACCESS DOORS

A. General Description: Fabricate doors airtight and suitable for duct pressure class.

B. Door: Double wall, duct mounting, and rectangular; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

1. Manufacturers:
   a. American Warming and Ventilating.
   b. CESCO Products.
   c. Ductmate Industries, Inc.
   d. Flexmaster U.S.A., Inc.
   e. Greenheck.
   g. Nailor Industries Inc.
   h. Ventfabrics, Inc.
   i. Ward Industries, Inc.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Provide number of hinges and locks as follows:
   a. Less than 12 Inches square: Secure with two sash locks.
   b. Up to 18 Inches square: Two hinges and two sash locks.
   c. Up to 24 by 48 inches: Three hinges and two compression latches with outside.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Flexmaster U.S.A., Inc.
   2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.7 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Corp.
   3. Ventfabrics, Inc.
   
B. General Description: Flame-retardant or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

C. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches wide attached to two strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Select metal compatible with ducts.

   1. Minimum Weight: 26 oz./sq. yd..
   2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
   3. Service Temperature: Minus 40 to plus 200 deg F.

2.8 FLEXIBLE DUCTS

A. Manufacturers:
   1. Flexmaster U.S.A., Inc.
   2. Hart & Cooley, Inc.

B. Noninsulated-Duct Connectors: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
3. Temperature Range: Minus 20 to plus 175 deg F.

C. Insulated-Duct Connectors: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; aluminized vapor barrier film.
   1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
   3. Temperature Range: Minus 20 to plus 175 deg F.

D. Flexible Duct Clamps: Nylon strap, in sizes 3 through 18 inches to suit duct size.

2.9 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 APPLICATION AND INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Provide duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

D. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

E. Provide balancing dampers at points on supply, return, and exhaust systems where branches lead from larger ducts as required for air balancing. Install at a minimum of two duct widths from branch takeoff.

F. Provide test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire dampers, with fusible links, according to manufacturer's UL-approved written instructions.

H. Install duct access doors to allow for inspecting, adjusting, and maintaining accessories and terminal units as follows:
   1. On both sides of duct coils.
2. Downstream from volume dampers and equipment.
3. Adjacent to fire or smoke dampers, providing access to reset or reinstall fusible links.
4. To interior of ducts for cleaning; before and after each change in direction, at maximum 50-foot spacing.
5. On sides of ducts where adequate clearance is available.

I. Install the following sizes for duct-mounting, rectangular access doors:

1. One-Hand or Inspection Access: 8 by 5 inches.
2. Two-Hand Access: 12 by 6 inches.

J. Install the following sizes for duct-mounting, round access doors:

1. One-Hand or Inspection Access: 8 inches in diameter.
3. Head and Hand Access: 12 inches in diameter.

K. Label access doors according to Division 23 Section "Mechanical Identification."

L. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

M. For fans developing static pressures of 5-inch wg and higher, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect terminal units to supply ducts with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect flexible ducts to metal ducts with draw bands.

P. Install duct test holes where indicated and required for testing and balancing purposes.

3.2 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Adjust fire dampers for proper action.

C. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting and Balancing."

END OF SECTION 23 33 00
PART 1 - GENERAL

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

1.2 SUMMARY
   A. This Section includes the following:
      1. Inline centrifugal ventilators.

1.3 PERFORMANCE REQUIREMENTS
   A. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS
   A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
      1. Certified fan performance curves with system operating conditions indicated.
      2. Certified fan sound-power ratings.
      3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
      4. Material thickness and finishes, including color charts.
      5. Dampers, including housings, linkages, and operators.
   B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   C. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
   B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
   C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

PART 2 - PRODUCTS

2.1 IN-LINE CENTRIFUGAL FANS

A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:

1. Greenheck.
2. Loren Cook Company.
3. Twin City Fans.

B. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel, outlet guide vanes, fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing; with wheel, inlet cone, and motor on swing-out service door.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:

1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
2. Companion Flanges: For inlet and outlet duct connections.
3. Fan Guards: 1/2- by 1-inch mesh of galvanized steel in removable frame. Provide guard for inlet or outlet for units not connected to ductwork.

2.2 MOTORS

A. Enclosure Type: Totally enclosed, fan cooled.
2.3 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

C. Support suspended units from structure using threaded steel rods and elastomeric hangers having a static deflection of 1 inch.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 23 Section "Mechanical Identification."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding."

D. Connect wiring according to Division 26 Section "Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connects to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
3. Verify that cleaning and adjusting are complete.
4. Adjust damper linkages for proper damper operation.
5. Verify lubrication for bearings and other moving parts.
6. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
7. Shut unit down and reconnect automatic temperature-control operators.
8. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 23 Section “Testing, Adjusting and Balancing” for testing, adjusting and balancing procedures.

C. Lubricate bearings.

END OF SECTION 233423
SECTION 23 37 13 – DIFFUSERS AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers and grilles.

B. Related Sections include the following:

1. Division 23 Section "Duct Accessories" for fire dampers and volume-control dampers not integral to diffusers and grilles.

1.3 SUBMITTALS

A. Product Data: For each product indicated, include the following:

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
2. Diffuser and Grille Schedule: Indicate Drawing designation, quantity, model number, size, and accessories furnished.

B. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling-mounted items including lighting fixtures, diffusers, speakers, sprinklers, access panels and special moldings.
5. Duct access panels.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Products: Subject to compliance with requirements, provide one of the products specified.
2.2 GRILLES AND REGISTERS

A. As scheduled.

B. Adjustable Bar Diffuser:

1. Products:
   a. Krueger.
   b. Metalaire.
   c. Price.
   d. Titus.
   e. Tuttle & Bailey.

2. Finish: Baked enamel, Aluminum.


C. Fixed Face Grille:

1. Manufacturers:
   a. Krueger.
   b. Metalaire.
   c. Price.
   d. Titus.
   e. Tuttle & Bailey.


3. Finish: Baked enamel, white.


2.3 CEILING DIFFUSER OUTLETS

A. As scheduled.

B. Face Diffuser:

1. Manufacturers:
   a. Krueger.
   b. Metalaire.
   c. Price.
   d. Titus.
   e. Tuttle & Bailey.

2. Finish: Baked enamel, white.

3. Face Size: 24 X 24 or 12 X 12, as scheduled on plans.

4. Mounting: Surface or T-bar, as scheduled on plans.

5. Pattern: Four-way core style.

2.4 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas where diffusers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.2 INSTALLATION

A. Install diffusers and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practicable. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers and grilles with airtight connections to ducts and to allow service and maintenance of dampers and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 234320 - AIR PURIFICATION SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

A. This section describes the design, performance and installation of an air purification system intended for use as part of another manufacturer’s air handling unit or mounted on the duct as shown on the plans, details and equipment schedules.

1.2 REFERENCED CODES & STANDARDS

A. The following codes and standards are referenced throughout. The edition to be used is that currently enforced by the authority having jurisdiction (AHJ) or in absence of such direction that referenced by the current enforceable IBC code or as indicated by the contract documents, except where specifically referenced by this section of the specifications.

1. ASHRAE Standards 62 & 52
2. National Electric Code NFPA 70
3. UL 86-2007 including ozone chamber test required as of December 21, 2007
4. The cold plasma equipment and power supply shall be UL and CE listed.
5. The technology shall have been tested to DO-160 by an independent lab and successfully passed all requirements for shock, vibration, EMF and line noise. Manufacturers not tested to DO-160 shall not be acceptable.

1.3 RELATED WORK

A. Testing, Adjusting and Balancing
B. Facility Access and Protection
C. Ductwork
D. Filters
E. Water and Refrigerant Piping
F. Electrical Wiring
G. Control Wiring

1.4 QUALITY and IP ASSURANCE

A. Basis of design is Global Plasma Solutions. Active Air Solutions and American Ion shall be considered equal subject to meeting all specifications herein. All other manufacturers requesting prior approval must submit product drawings, specifications and test results specified in section 2.2 at least four weeks prior to bid date and shall provide proof they are a licensed manufacturer not infringing upon patent # 9,289,779 B2. Manufacturers not having a license based on patent # 9,289,779 B2 shall not be acceptable.

B. The Air Purification System shall be a product of an established manufacturer within the USA and shall be made of 100% USA sourced raw materials and components. Ion modules made outside the USA and assembled in the USA on mounting plates shall not be acceptable.

C. A qualified representative from the manufacturer shall be available to inspect the installation of the air purification system to ensure installation in accordance with manufacturer’s recommendation.
D. Technologies that do not address gas disassociation such as UV Lights, Powered Particulate Filters and/or polarized media filters shall not be considered. Uni-polar ion generators shall not be acceptable. “Plasma” particulate filters shall not be acceptable. Any system containing titanium dioxide (TiO2), which has been listed by the CDC as a known carcinogen, shall not be acceptable.

E. Projects designed using ASHRAE Standard 62, IAQ Procedure shall require the manufacturer to provide Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air scheduled with the technology submitted. The manufacturer shall provide independent test data on a previous installation performed within the last two years and in a similar application, that proves compliance to ASHRAE 62 and the accuracy of the calculations. The data shall be based on the manufacturer’s use of the same make and model number as the equipment submitted on this project.

F. The Air Purification Technology shall have been tested by UL or Intertek/ETL to prove conformance to UL 867-2007 including the ozone chamber testing and peak ozone test for electronic devices. Manufacturers that achieved UL 867 prior to December 21, 2007 and have not been tested in accordance with the newest UL 867 standard with the ozone amendment shall not be acceptable. All manufacturers requesting prior approval shall submit their independent UL 867 test data with ozone results to the engineer for preliminary review and during the submittal process. All manufacturers shall submit a copy with their quotation. Contractors shall not accept any proposal without the proper ozone testing documentation.

G. The maximum allowable ozone concentration per the UL 867-2007 chamber test shall be 0.007 PPM. The maximum peak ozone concentration per the UL 867-2007 peak test as measured 2 inches away from the electronic air cleaner’s output shall be no more than 0.0042 PPM. Manufacturers with ozone output exceeding these ozone values shall not be acceptable.

1.5 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for ion generators including:

1. Schedule of plasma generators indicating unit designation, number of each type required for each unit/application.
2. Data sheet for each type of plasma generator, and accessory furnished; indicating construction, sizes, and mounting details.
3. Performance data for each type of plasma device furnished.
4. Indoor Air Quality calculations using the formulas within ASHRAE Standard 62.1-2007 to validate acceptable indoor air quality at the quantity of outside air Scheduled (when projects are designed with outside air reduction).
5. Product drawings detailing all physical, electrical and control requirements.
6. Copy of UL 867 independent ozone test.
7. Statement on the manufacturer’s letterhead stating that the technology contains no titanium dioxide (TiO2).

B. Operating & Maintenance Data: Submit O&M data and recommended spare parts lists.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver in factory fabricated shipping containers. Identify on outside of container type of product and location to be installed. Avoid crushing or bending.
B. Store in original cartons and protect from weather and construction work traffic.
C. Store indoors and in accordance with the manufacturers’ recommendation for storage.

1.7 WARRANTY

A. Equipment shall be warranted by the manufacturer against defects in material and workmanship for a period of eighteen months after shipment or twelve months from owner acceptance, whichever occurs first. Labor to replace equipment under warranty shall be provided by the owner or installing contractor.

PART 2 - PRODUCTS

2.1 GENERAL

A. The air purification system(s) shall be of the size, type, arrangement and capacity indicated and required by the unit furnished and shall be of the manufacturer specified.
B. Basis of Design: Global Plasma Solutions
C. All other Suppliers of comparable products requesting prior approval shall:

1. Submit for prior approval four weeks in advance in accordance with the requirements of Section 15010.
2. In addition, manufacturers submitting for prior approval for Bi-Polar Ionization must as part of the prior approval request provide their ASHRAE 62.1-2007 calculations that prove conformance to the ASHRAE Standard with the reduction of outside air to the scheduled values. A letter on the manufacturer's letterhead requesting prior approval must accompany the request for prior approval stating their calculations are ASHRAE compliant. A third party validation study performed on a previous installation of the same application using the same make and model equipment shall also be included.
3. Submit independent test data from ETL or UL showing ozone levels produced during the UL 867 ozone chamber test. Manufacturers without this test data shall not be acceptable.
4. Submit pathogen testing per section 2.2.
5. Submit at least two other end user references in the same application with contact phone number, email, equipment used and application for the equipment at that facility. Manufacturers not having the above references in similar applications using the same equipment models as proposed on the current project shall not be acceptable.
6. Ionization bars manufactured using DC output ionization modules shall not be permitted due to corrosion, ion short circuiting, intermittent coil coverage and shock hazard.
7. Ionization bars manufactured using ion modules not having epoxy coating all circuit boards and internal components shall not be acceptable.
8. Manufacturers submitting as an alternate shall include their DO-160 test results.
9. It is the responsibility of any alternate manufacturer and mechanical contractor proposing an alternate to the basis of design to confirm any proposed substituted product does not infringe on the patented intellectual property of the basis of design. The engineer and owner recognize the basis of design holds multiple patents and multiple patents are pending.

2.2 BI-POLAR IONIZATION DESIGN & PERFORMANCE CRITERIA
A. Each piece of air handling equipment, so designated on the plans, details, equipment schedules and/or specifications shall contain a Plasma Generator with Bi-polar Ionization output as described here within.

B. The Bi-polar Ionization system shall be capable of:

1. Effectively killing microorganisms downstream of the bi-polar ionization equipment (mold, bacteria, virus, etc.).
2. Controlling gas phase contaminants generated from human occupants, building structure, furnishings and outside air contaminants.
3. Capable of reducing static space charges.
4. Effectively reducing space particle counts.
5. When mounted to the air entering side of a cooling coil, keep the cooling coil free from pathogen and mold growth.
6. All manufacturers shall provide documentation by an independent NELEC accredited laboratory that proves the product has minimum kill rates for the following pathogens given the allotted time and in a space condition:

   A. MRSA - >96% in 30 minutes or less
   B. E.coli - > 99% in 15 minutes or less
   C. TB - > 69% in 60 minutes or less
   D. C. diff - >86% in 30 minutes or less
   E. Noro Virus - > 93.5% in 30 minutes or less
   F. Legionella - > 99.7% in 30 minutes or less

Manufacturers not providing the equivalent space kill rates shall not be acceptable. All manufactures requesting prior approval shall provide to the engineer independent test data from a NELAC accredited independent lab confirming kill rates and time meeting the minimum requirements stated in section 2.2 B, points 6A, 6B and 6C. Products tested only on Petri dishes to prove kill rates shall not be acceptable. Products being sold under different trade names than those tested shall not be acceptable.

C. The bi-polar ionization system shall operate in a manner such that equal amounts of positive and negative ions are produced. Uni-polar ion devices shall not be acceptable. Ionizers with positive and negative output (DC type) shall not be acceptable. All ionizers provided shall be AC type ionizers with one electrode pulsing between positive and negative.

   1. Air exchange rates may vary through the full operating range of a constant Volume or VAV system. The quantity of air exchange shall not be increased due to requirements of the air purification system.
   2. Velocity Profile: The air purification device shall not have maximum velocity profile.

D. Humidity: Plasma Generators shall not require preheat protection when the relative humidity of the entering air exceeds 85%. Relative humidity from 0 - 100%, condensing, shall not cause damage, deterioration or dangerous conditions within the air purification system. Air purification system shall be capable of wash down duty.

E. Equipment Requirements:

   1. Electrode Specifications (Bi-polar Ionization):
      a. Each alternating current (AC) Ionization Bar with Bi-polar Ionization output shall include a minimum of sixteen 316 medical grade stainless steel ion needles per foot of coil face width shall be provided. The entire cooling coil width shall have equal distribution of ionization across the face. Systems without ion needles at least 0.75” apart shall not be acceptable. The plasma electrode shall require no more than one inch in the direction of airflow for mounting. All hardware
required for mounting shall be provided by the air purification manufacturer except self tapping screws for the power supply. Bi-polar ionization tubes manufactured of glass and steel mesh shall not be acceptable due to replacement requirements, maintenance, and performance output reduction over time, ozone production and corrosion. Plasma generators and bars with recessed needles shall not be acceptable.

b. Electrodes shall be energized when the main unit disconnect is turned on.
c. The ionization output shall be a minimum of 35 million ions/cc per inch of cooling coil width as measured 1 inch from the cold plasma needles.
d. Ionization bars shall be provided with magnet mounting kits to prevent penetration into cooling coils.

F. Air Handler Mounted Units:

1. Where so indicated on the plans and/or schedules Plasma Generator(s) shall be supplied and installed. The mechanical contractor shall mount the Plasma Generator and wire it to the remote mount power supply using the high voltage cables provided by the air purification manufacturer. A 115VAC or 230VAC circuit shall be provided to the plasma generator power supply panel. Each plasma generator shall be designed with an aluminum casing, liquid tight flexible conduit and a high voltage quick connector.

G. Plasma Requirements

1. Plasma Generators with Bi-polar ionization output shall be capable of controlling gas phase contaminants and shall be provided for all equipment listed above.
   a. The Bi-polar ionization system shall consist of Bi-Polar Plasma Generator and power supply. The Bi-polar system shall be installed where indicated on the plans or specified to be installed. The device shall be capable of being powered by 115VAC or 230VAC without the use of an external transformer. Ionization systems requiring isolation transformers shall not be acceptable.
   b. Ionization Output: The ionization output shall be controlled such that an equal number of positive and negative ions are produced (AC Ionizers only are acceptable). Imbalanced levels shall not be acceptable.
   c. Ionization output from each electrode shall be a minimum of 35 million ions/cc when tested at 1” from the ionization generator. The ionization bar shall provide 35 million ions/cc per inch of bar over the entire width of the ionization bar. Bars with needles spaced further apart will not be acceptable.

2. Ozone Generation
   a. The operation of the electrodes or Bi-polar ionization units shall conform to UL 867-2007 with respect to ozone generation.

H. Electrical Requirements:

1. Wiring, conduit and junction boxes shall be installed within housing plenums in accordance with NEC NFPA 70. Plasma Generator shall accept an electrical service of 115 VAC or 230VAC, 1 phase, 50/60 Hz. The contractor shall coordinate electrical requirements with air purification manufacturer during submittals.

I. Control Requirements:

1. All Plasma Generators shall have internal short circuit protection, overload protection, and automatic fault reset.
2. The ionization system shall be provided with a stand-alone, independent ion sensor designed for duct mounting to monitor the ion output and report to the BAS system that
the ion device is working properly. Ion systems provided without an independent ion sensor, shall not be permitted. The control voltage to power the ion sensor shall be 12VDC or 24VAC to 240VAC and draw no more than 150mA of current. The sensor shall provide at minimum, dry contact status to the BAS and optionally a BacNet or Lonworks interface as specified on the control drawings. Manufacturers not providing a stand-alone ion sensor shall not be acceptable.

3. The installing contractor shall mount and wire the Plasma device within the air handling unit specified or as shown or the plans. The contractor shall follow all manufacturer IOM instructions during installation.

4. A fiberglass NEMA 4X panel with Plasma On/Off Indicator Light (interfaced with stand-alone ionization detector), Ionization Output On/Off Indicator Light and an On/Off Illuminated Switch shall be provided to house the power supply.

PART 3 - EXECUTION

3.1 GENERAL

A. The Contractor shall be responsible for maintaining all air systems until the owner accepts the building (Owner Acceptance).

3.2 ASSEMBLY & ERECTION: PLASMA GENERATOR

A. All equipment shall be assembled and installed in a workman like manner to the satisfaction of the owner, architect, and engineer.

B. Any material damaged by handling, water or moisture shall be replaced, by the mechanical contractor, at no cost to the owner.

C. All equipment shall be protected from dust and damage on a daily basis throughout construction.

3.3 TESTING

A. Provide the manufacturers recommended electrical tests.

3.4 COMMISSIONING & TRAINING

A. A manufacturer's authorized representative shall provide start-up supervision and training of owner's personnel in the proper operation and maintenance of all equipment.

END OF SECTION 234320
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Packaged commercial gas/electric rooftop HVAC units.

1.2 SUBMITTALS

A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures.

B. Product Data: Submit product data for specified products.

C. Shop Drawings:

1. Submit shop drawings in accordance with Section 01330 - Submittal Procedures.
2. Indicate:
   a. Equipment, piping and connections, together with valves, strainers, control assemblies, thermostat controls, auxiliaries and hardware, and recommended ancillaries which are mounted, wired and piped ready for final connection to building system, its size and recommended bypass connections.
   b. Piping, valves and fittings shipped loose showing final location in assembly.
   c. Control equipment shipped loose, showing final location in assembly.
   d. Dimensions, internal and external construction details, recommended method of installation with proposed structural steel support, mounting curb details, sizes and location of mounting bolt holes; include mass distribution drawings showing point loads.
   e. Detailed composite wiring diagrams for control systems showing factory installed wiring and equipment on packaged equipment or required for controlling devices or ancillaries, accessories and controllers.
   g. Details of vibration isolation.
   h. Estimate of sound levels to be expected across individual octave bands in dB.
   i. Type of refrigerant used.
   j. Plan view, front view end view, back view and curb detail with dimensions.

D. Quality Assurance:

1. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
2. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria and physical requirements.
3. Manufacturer’s Instructions: Manufacturer’s installation instructions.

E. Manufacturer’s Field Reports: Manufacturer's field reports specified.
F. Closeout Submittals: Submit following:
   2. Operation and Maintenance Data: Operation and maintenance data for installed products in accordance with Division 1 Closeout Submittals (Maintenance Data and Operation Data) Section. Include methods for maintaining installed products and precautions against cleaning materials and methods detrimental to finishes and performance. Include names and addresses of spare part suppliers.
   3. Provide brief description of unit, with details of function, operation, control and component service.
   4. Provide equipment inspection report and equipment operation test report.
   5. Commissioning Report: Submit commissioning reports, report forms and schematics.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer experienced in performing work of this section who has specialized in installation of work similar to that required for this project.
   2. Pre-installation Meetings: Conduct pre-installation meeting to verify project requirements, manufacturer's installation instructions and manufacturer's warranty requirements. Comply with Division 1 Project Management and Coordination (Project Meetings).

1.4 DELIVERY, STORAGE & HANDLING

A. General: Comply with Division 1 Product Requirements.

B. Ordering: Comply with manufacturer’s ordering instructions and lead time requirements to avoid construction delays.

C. Packing, Shipping, Handling and Delivery:
   1. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
   2. Ship, handle and unload units according to manufacturer’s instructions.

D. Storage and Protection:
   1. Store materials protected from exposure to harmful weather conditions.
   2. Factory shipping covers to remain in place until installation.

1.5 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer’s Warranty: Submit, for Owner’s acceptance, manufacturer’s standard warranty document executed by authorized company official. Manufacturer’s warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.
C. Warranty: Commencing on Date of Installation.

1. Compressors: 5 years (limited).
2. Other Covered System Components: 1 year (limited).
3. Stainless Steel Heat Exchangers: 10 years (limited).
4. Unit Controller 3 years (limited).

PART 2 PRODUCTS

2.1 ROOFTOP UNITS

A. Manufacturers: Lennox (Basis of Design), Trane, Aaon or prior approved equal.

B. Products/Systems to include the following equipment:

1. Cabinet:
   a. Heavy gauge steel panels.
   b. Pre-painted steel panels.
   c. Heavy Gauge galvanized steel base rail.
   d. Rigging holes on all four corners.
   e. Forklift slots (on three sides, not directly below condenser coil) on base rail.
   f. Raised or flanged edges around duct and power entry openings.
   g. Electrical lines and gas lines can be brought through the base of the unit or through horizontal knockouts.
   h. Insulation:
      1) All panels adjacent to conditioned air are fully insulated with foil faced fiberglass insulation.
      2) Unit base is fully insulated.
      3) Unit base insulation also serves as a roof curb seal.
   i. Access Panels: Hinged for compressor/controls/heating areas, blower access and air filter/economizer access; and, sealed with quarter-turn latching handles and tight air and water seal.
   j. Corrosion resistant double sloped condensate Drain Pan.
   k. Service Valves

2. Cooling System:
   a. Refrigerant type: R-410A.
   b. Capable of operating from 0 - 125 degrees F (-18 - 52 degrees C) without installation of additional controls.
   c. Compressors:
      1) Scroll Type.
      2) Resiliently mounted on rubber mounts for vibration isolation.
      3) Overload Protected
      4) Internal excessive current and temperature protection
      5) Isolated from condenser and evaporator fan air streams
6) Refrigerant cooled
d. TXV
e. High pressure switch
f. Freezestat
g. High capacity filter driers
h. Crankcase heater
i. Low pressure switch

3. Coil Construction:
a. Condensing/evaporator coil general construction:
   1) Aluminum Rippled and Lanced fins.
   2) Copper tube construction.
   3) Aluminum fins mechanically bonded to copper tubes.
   4) All coils are high pressure leak tested at manufacturing facility.
b. Evaporator Coils:
   1) With balanced port thermal expansion valves, freeze protection on each
      compressor circuit, pressure and leak tested to 500 psi.
   2) Each compressor circuit on coil divided across face of coil and active through full
      depth of coil.
c. Condenser Coils:
   1) Pressure and leak tested to 500 psi, nonferrous coils with enhanced aluminum
      fins mechanically bonded to durable copper tubes.
   2) Formed construction or slab construction.
   3) Hot gas reheat (where scheduled): Provide hot gas reheat coils installed by the
      unit manufacturer. The hot gas reheat coil capacity shall be cataloged by the
      unit manufacturer and be a standard product of the unit manufacturer, not a
      third party device. The hot gas reheat controls shall include integration to the
      unit microprocessor controller and be provided with a humidity sensor for field
      installation by the controls contractor. All piping, solenoid valves and controllers
      shall be included. The hot gas reheat algorithm shall allow for active
      dehumidification even when there is no cooling demand.

4. Wiring:
a. Keyed and labeled connections, color coded and continuously marked wire to identify
   point-to-point component connections.
b. Not in contact with hot-gas refrigerant lines or sharp metal edges.

5. Electric Heating System:
a. Electrical resistance heater
b. Reset thermal limit protection
c. Single point power supply
d. Heater Element:
   1) Nickel chromium wire
   2) Individually fused.
e. Electric heater shall slide out of unit for service

6. Heating Controls:
a. Support 2 stages of heating control from thermostat or DDC
b. With delay time of 30 seconds between low and high heat stages

7. Supply Air Fan Motor and Drives:
   a. Belt drive
   b. Permanently lubricated ball bearings (for belt drive motors)
   c. Thermal overload protected motors with automatic reset
d. Adjustable sheaves on belt drive motors for blower speed adjustment
e. Optional low and high static motor/drive combinations and optional drive kits
f. Auto Blower Belt Tensioner

8. Supply Air Fan:
   a. Double inlet type, galvanized steel with forward curved blades
   b. Statically and dynamically balanced
c. Continuous or automatic control for occupied periods

9. Supply Air Filters:
   a. Disposable 2 inch, MERV 8 minimum.

10. Condenser Fan Motor:
    a. ECM motors on 3-5 ton models. Direct drive with permanently lubricated ball bearings. With the exception of the first sentence, these three items (a, b, c) are not mentioned in the EHB
    b. Watertight with thermal overload protection and automatic reset
c. Motor mount isolated from fan safety guard

11. Condenser Fans:
    a. Corrosion resistant propeller type

12. Unit Controller:
    a. Solid state control board to operate unit
    b. Scrolling digital display
c. Shall provide a 5° F temperature difference between cooling and heating set points to meet ASHRAE 90.1 Energy Standard
d. Shall provide and display alarms, alarm history and system status
e. Service run test capability
f. Shall accept input from a CO2 sensor (both indoor and outdoor)
g. Economizer control
h. Blower on/off delay
i. 2-stage heat/4-stage cool thermostat compatible and warm-up mode
j. Diagnostics code storage
k. DDC compatible
l. Indoor air quality input
m. Low ambient controls
n. Runtime
o. Blower proving switch strike 3
p. Realtime clock (timestamps)
q. Guided setup
r. USB memory stick communication interface

13. Accessories:
   a. Motorized Outside Air Damper: Factory Installed
   b. Dehumidification system with secondary coil: Factory Installed
   c. Smoke detector return: Factory Installed
   d. Roof curb: Field Installed
   e. Hail Guards: Field Installed
   f. Disconnect Switch: Factory Installed
   g. GFCI Service Outlets: Factory Installed (field wired)
   h. Programmable Thermostat: Digital display, low voltage with subbase and battery backup to control compressor and evaporator fan or as noted per plans.

PART 3 EXECUTION

3.1 MANUFACTURER’S INSTRUCTIONS
   A. Compliance: Comply with manufacturer’s written data, including product technical bulletins, product catalog installation instructions, product carton installation instructions and manufacturer’s sheets.

3.2 EXAMINATION
   A. Site Verification of Conditions: Verify substrate conditions, which have been previously installed under other sections, are acceptable for product installation in accordance with manufacturer’s instructions

3.3 INSTALLATION
   A. Install packaged rooftop units in accordance with manufacturer’s instructions on roof curbs provided by manufacturer as indicated.

END OF SECTION 237413
PART 1 – GENERAL

1.1 SYSTEM DESCRIPTION

A. The variable capacity air conditioning system shall be an Inverter Driven series split system. The basis of design shall be Daikin. Acceptable alternate manufacturers shall be Mitsubishi, LG, Trane or approved equal. The system shall consist of a wall mounted evaporator model exclusively matched to an outdoor model direct expansion (DX), air-cooled, swing, variable speed, inverter driven compressor using R-410A refrigerant of equal and matching nominal tonnage. The outdoor unit is a horizontal discharge, variable speed, single fan unit. The system shall have a self diagnostic function, 3-minute time delay mechanism and have a factory pre-charge of R-410A. The system shall have automatic restart capability after a power failure has occurred and a low voltage cut-off feature to prevent stalling during power supply issues.

1.2 QUALITY ASSURANCE

A. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

B. All wiring shall be in accordance with the National Electric Code (NEC).

C. Each combination shall be rated in accordance with Air Conditioning Refrigeration Institute’s (ARI) Standard 210/240 and bear the ARI label.

D. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.

E. A holding charge of dry nitrogen shall be provided in the evaporator.

F. System efficiency shall be approximately as scheduled.

1.3 DELIVERY, STORAGE AND HANDLING

A. Unit shall be stored and handled according to the manufacturer’s recommendations.

PART 2 – WARRANTY

2.1 LIMITED WARRANTY

The equipment manufacturer shall warrant to the customer who is the original owner and user of the products specified above that under normal use and maintenance for comfort cooling and conditioning applications such products will be free from defects in material or workmanship. This warranty applies to parts only and is limited in duration to two (2) years from the earlier to occur of (a) the date of original installation, whether or not actual use begins on that date, or (b) eighteen (18) months from the date of shipment. Customer must present proof of the original date of receipt and of installation of the Product in order to establish the effective date of this warranty. Otherwise the effective date will be deemed to be the date of manufacture plus sixty (60) days. Repaired or replacement parts are warranted for the balance of the warranty period applicable to the original part following the date on which the repaired or replacement part is provided to the customer.
2.2 EXTENDED WARRANTY

For its compressors only, the equipment manufacturer provides the above warranty (which is applicable to parts only) for a five (5) year period. This extended warranty for compressors is limited in duration to five (5) years from the earlier to occur of (a) the date of original installation, whether or not actual use begins on that date, or (b) eighteen (18) months from the date of shipment, and applies to the compressor and compressor parts only. The effective date of this extended warranty shall be established as above.

2.3 INSTALLATION REQUIREMENTS

The system shall be installed by a factory trained contractor/dealer.

PART 3 – PERFORMANCE

3.1 The system performance shall be in accordance with ARI 210/240 test conditions and as scheduled. The cooling performance is based on 80°F DB / 67°F WB for the indoor unit and 95°F DB / 75°F WB for the outdoor unit and 25 feet of piping. The heating performance is based on 70°F DB / 60°F WB for the indoor unit and 47°F DB / 43°F WB for the outdoor unit and 25 feet of piping.

3.2 The operating range in cooling will be 14°F DB ~ 115°F DB, and 0°F DB ~ 115°F DB when used with an optional wind baffle.

3.3 The operating range in heating will be 5°F DB ~ 64°F WB

3.4 The system shall be capable of maximum refrigerant piping of 98 feet, with 66 feet maximum vertical difference, without any oil traps or additional components.

PART 4 – PRODUCTS

4.1 INDOOR UNIT

General:
The indoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. Both liquid and suction lines must be individually insulated between the outdoor and indoor units.

A. Unit Cabinet:
   1. The indoor unit shall have a white, “flat screen” finish.
   2. The drain and refrigerant piping shall be accessible from six (6) positions for flexible installation (right side, right back, and right bottom; and left side, left back, and left bottom.
   3. The cabinet shall be supplied with a mounting plate to be installed onto a wall for securely mounting the cabinet.

B. Fan:
   1. The evaporator fan shall be an assembly consisting of a direct-driven fan by a single motor.
   2. The fan shall be statically and dynamically balanced and operate on a motor with permanent lubricated bearings.
   3. An auto-swing louver for adjustable air flow (vertically) is standard via the wireless remote control furnished with each system.
   4. The indoor fan shall offer a choice of five speeds, plus quiet and auto settings.
C. Filter:
   1. The return air filter provided will be a mildew proof, removable and washable filter.

D. Coil:
   1. The evaporator coil shall be a nonferrous, aluminum fin on copper tube heat exchanger.
   2. All tube joints shall be brazed with silver alloy or phosphorus.
   3. All coils will be factory pressure tested.
   4. A condensate pan shall be provided under the coil with a drain connection.

E. Electrical:
   1. The outdoor unit shall be powered with 208-230 volts, 1 phase, and 60 hertz power. The indoor unit shall receive 208-230 volt, 1 phase, 60 hertz power from the outdoor unit.
   2. The allowable voltage range shall be 187 volts to 253 volts.

F. Control:
   1. The unit shall have a backlit, wireless remote infra-red controller capable to operate the system. It shall have Cooling Operation, Automatic Operation, Dry Operation and Fan Only Operation.
   2. The controller shall consist of an On/Off Power switch, Mode Selector, Fan Setting, Swing Louver, On/Off Timer Setting, Temperature Adjustment, °C or °F Temperature Display, and Powerful Operation.
      i. On/Off switch powers the system on or off.
      ii. Mode selector shall operate the system in auto, cool, fan or dry operation
      iii. Fan setting shall provide five fan speeds, plus quiet and auto settings.
      iv. Swing louver shall adjust the airflow (horizontal and vertical) blades.
      v. On/Off timer is used for automatically switching the unit on or off.
      vi. Temperature adjustment allows for the increase or decrease of the desired temperature.
      vii. Powerful operation allows quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time period.
   3. The remote control shall perform Fault Diagnostic functions which may be system related, indoor unit or outdoor unit related depending on the fault code.
   4. Temperature range on the remote control shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.
   5. The indoor unit microprocessor has the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote control.

4.2 OUTDOOR UNIT

General:
The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be complete factory assembled and pre-wired with all necessary electronic and refrigerant controls.

A. Unit Cabinet:
   1. The outdoor unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

B. Fan:
   1. The fan shall be a direct drive, propeller type fan.
   2. The motor shall be inverter driven, permanently lubricated type bearings, inherent.
3. The fan shall be capable of operating in “silent operation” which lowers the outdoor fan speed in either cool, heat or auto modes.
4. A fan guard is provided on the outdoor unit to prevent contact with fan operation.
5. Airflow shall be horizontal discharge.

C. Coil:
1. The outdoor coil shall be nonferrous construction with corrugated fin tube.
2. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film type E1.
3. Refrigerant flow from the condenser will be controlled via a metering device.

D. Compressor:
1. The compressor shall be a swing inverter-driven compressor.
2. The outdoor unit shall have an accumulator and four-way reversing valve.
3. The compressor shall have an internal thermal overload.
4. The outdoor unit can operate with a maximum vertical height difference of 66 feet and overall maximum length of 98 feet without any oil traps or additional components.

E. Electrical:
1. The electrical power requirement is 208-230 volt, 1-phase, and 60 Hz power.
2. The voltage range limitations shall be a minimum of 187 volts and a maximum of 253 volts.
3. The outdoor shall be controlled by a microprocessor located in the outdoor and indoor units via commands from the infrared remote controller.

END OF SECTION 23 81 35
SECTION 260000 - GENERAL PROVISIONS

PART 1 - GENERAL

1.1 SCOPE

A. The electrical portion of this project includes all labor, materials, equipment, etc., required to provide the complete electrical work to fulfill the intent of the Contract Documents.

1.2 RELATED DOCUMENTS

A. All applicable provisions of Division 0 and 1 govern work under this division. Refer to these articles in the specifications for additional information.

B. All work shall be in compliance with the currently enforced edition of the applicable state, national, and local ordinance and building codes, and the National Electric Code. No additional compensation shall be granted for work which must be changed as a result of the work not originally complying with the codes and standards, etc.

C. Refer to each section for additional applicable codes and reference standards.

1.3 FEES, PERMITS AND TAXES

A. This Contractor is responsible for all inspection fees and permits required by local authorities having jurisdiction. The Contractor is also responsible for all taxes levied for labor and materials associated with the electrical portion of the work. After completion of the work, a certificate of final inspection shall be provided showing approval from the local Electrical Inspector.

B. This contractor is responsible for any fees, charges or installation costs charged by the local utility for the new electrical service provided.

1.4 SUBMITTALS

A. Submittals shall be provided for all items indicated. Product data shall be from published manufacturer's data. Data shall include enough information so that the Engineer can verify compliance with codes, standards, and the contract documents. Submittal shall not contain data that is not relevant to the equipment being submitted. The data shall be highlighted by arrows, underlining, etc. Broad, general data, is not acceptable. Data shall be presented at one time, in a neatly bound and organized manner.

B. The contractor shall provide and maintain at the site a set of prints which accurately represent the actual installation of all work under this Division. Any changes in sizes, locations, dimensions, etc. shall be shown. Changes in circuitry shall be clearly and completely indicated as the work progresses.

C. At the completion of the Project, a set of marked-up drawings, including DIMENSIONED, location of all underground conduit shall be provided to the owner.
1.5 OPERATING AND MAINTENANCE MANUALS AND INSTRUCTIONS

A. Operating and Maintenance Data includes printed information, such as manufacturer's installation instructions, manufacturer's service manuals, manufacturer's lubrication charts, standard wiring diagrams, and a parts list including the price of each item.

B. Mark each copy to show applicable choices and options. Where printed Operating and Maintenance Data includes information on several products that are not required, mark copies to indicate the applicable information.

C. Do not submit Operating and Maintenance Data until compliance with requirements of the Contract Documents has been confirmed.

D. Submittals: Submit 3 copies of each required submittal. The Engineer will return the copies marked with action taken and corrections or modifications required. Unless resubmittal is requested, the submittal may serve as the final submittal.

1.6 PRIOR APPROVAL

A. The contractor shall submit a list of proposed substitutions to the Engineer. All proposed substitutions shall be in writing to the Engineer, at least, ten (10) calendar days prior to bid opening. The submittal will list the proposed substitutions from published manufacturer's data, which cover the applicable features of the submitted equipment. Any approvals shall be issued in writing.

1.7 GUARANTEE

A. The contractor shall fully guarantee the installation against defects in materials and workmanship which may occur under normal usage for a period of one year after owner's acceptance. Defects shall be promptly remedied at no cost to the owner. This guarantee is in addition to, and not a limit to, any other guarantees or warranties.

1.8 DEFINITIONS. The following words and phases are defined:

A. "Indicated": The term "indicated" refers to graphic representations, notes, or schedules on the Drawings; or to other paragraphs or schedules in the Specifications and similar requirements in the Contract Documents. Terms such as "shown," "noted," "scheduled," and "specified" are used to help the user locate the reference. Location is not limited.

B. "Directed": Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean directed by the Architect/Engineer, requested by the Architect/Engineer, and similar phrases.

C. "Approved": The term "approved," when used in conjunction with the Architect's/Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Architect's/Engineer's duties and responsibilities as stated in the Conditions of the Contract.

D. "Regulations": The term "regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.

E. "Furnish": The term "furnish" means to supply and deliver to the Project site, ready for unloading, unpacking, assembly, installation, and similar operations.
F. "Install": The term "install" describes operations at the Project site including the actual unloading, temporary storage, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

G. "Provide": The term "provide" means to furnish and install, complete and ready for the intended use.

H. "Installer": An installer is the Contractor or another entity engaged by the Contractor, either as an employee, subcontractor, or contractor of lower tier, to perform a particular construction activity, including installation, erection, application, or similar operations. Installers are required to be experienced in the operations they are engaged to perform.

I. "Project site": is the space available to the Contractor for performing construction activities, either exclusively or in conjunction with others performing other work as part of the Project. The extent of the Project site is shown on the Drawings and may or may not be identical with the description of the land on which the Project is to be built.

J. "Testing Agencies": A testing agency is an independent entity engaged to perform specific inspections or tests, either at the Project site or elsewhere, and to report on and, if required, to interpret results of those inspections or tests.

1.9 INSPECTION OF THE SITE

A. The drawings are prepared from the most accurate information available. However, the contractor shall, prior to placing any bids, visit the site to verify existing conditions, proposed conduit routings, etc.

B. All proposals shall take these existing conditions and any speculated revisions needed into account. The contractor shall be fully responsible for his bid regardless of any additional site information which may be uncovered after a contract is signed.

1.10 CONSTRUCTION SAFETY

A. The plans and specifications do not include items necessary for the contractor to insure the safety of his personnel on the project construction site. Construction site safety for the project is the responsibility of the contractor. Reference other sections of these specifications for any additional information.

1.11 DAMAGE

A. The contractor shall be held accountable to repair, at no additional cost, any damage to existing wiring, piping, or other materials and equipment intended to remain.

1.12 DRAWINGS AND SPECIFICATIONS

A. Should be considered as complimentary to each other. What is required by one shall be binding as if required by both. If conflicts between plans and specifications are found, the Engineer shall be contacted to secure clarification, prior to bidding. The contractor shall verify all dimensions and existing conditions.
1.13 MANUFACTURER’S DRAWINGS AND DATA

A. Submit Shop Drawings for approval, for all items indicated below.
   1. Panelboards
   2. Disconnect Switches
   3. Lighting Control Devices
   4. Lighting

B. Provide O&M Manuals i.a.w, Paragraph 1.5, for all items indicated below.
   1. Panelboards
   2. Disconnect Switches
   3. Lighting Control Devices

PART 2 - EXECUTION

2.1 WORKMANSHIP

A. All work shall be done in a professional and complete manner by experienced craftsmen. Unsatisfactory workmanship shall be duly noted and corrected at the contractors expense.

B. Only new materials shall be used, unless otherwise indicated on plan or prior approved.

2.2 MANUFACTURER’S INSTALLATION INSTRUCTIONS

A. All equipment shall be installed in accordance with manufacturer’s installation instructions.

2.3 PROTECTION OF EQUIPMENT

A. The contractor shall provide protection of stored material and installed equipment against dirt, rust, moisture, and abuse from other trades. Where tarps or other cover is used, provide air circulation to prevent condensate build up. No materials or equipment shall be stored directly on the ground.

2.4 CONFLICTS, INTERFERENCES AND COORDINATION BETWEEN TRADES

A. Coordinate work so as to conform with the progress of the work of others. The drawings are only intended to indicate the extent, general location and arrangement, of conduit systems and equipment. Any questions regarding the information given on the plans shall be directed to the Engineer for clarification. The contractor shall refer to other sections of the specifications and other drawings such as structural, mechanical, etc., in order to eliminate conflicts when laying out his work. The contractor shall be responsible for the proper coordination of the electrical work with the installations under other Divisions for clearances, etc. Any changes required to avoid interferences shall be submitted to the Architect for approval and shall be made, as approved, without additional cost.

B. Code requirements shall have precedence over plans or specifications in the event of a conflict. If a discrepancy or conflict exists between specifications and drawings, drawings shall take precedence over specifications except as pertaining to quality. Manufacturer’s installation instructions shall govern the installation of all equipment.
C. Control wiring, schematics, or logic shown on plan is only intended to show the general intent. Such plans are not to be considered “shop drawings”. The contractor is responsible for determining and coordinating the detailed requirements, including but not limited to wiring, to interface systems and provide a fully functional system which follows the intent.

D. The contractor shall coordinate with equipment suppliers for any requirements specific to the equipment provided which may not be shown on the plans or given in the specifications. The contractor shall include the provision and installation of such requirements in his bid. The contractor shall coordinate with equipment suppliers, prior to bid, to determine what ancillary equipment is or is not provided with the equipment, such as lugs, terminal blocks, etc.

E. Equipment requiring set grades or elevations and piping has precedence over conduit, boxes, etc. as to location.

F. The contractor shall coordinate with other equipment providers to insure correct operation of the equipment, such as, phase rotation, interlocking, accessibility, etc.

G. Low voltage temperature control systems for HVAC systems including controls, relays, time clocks, wiring and devices will be furnished and wired under Division 23. 120Vac wiring required in support of HVAC and other mechanical/plumbing systems shall be furnished and wired under Division 26.

H. The contractor shall examine the Architectural plans for the location of suitable openings and aisles for the passage of equipment to be installed under this Division. The contractor shall be responsible for having suitable openings and aisles left open until his equipment has been properly installed.

I. Except as otherwise noted, it shall be understood that the indication and/or description of any item, in the drawings or specifications, or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

J. It shall be understood that the plans are not intended to indicate exact raceway routings. Determination as to the routing shall be made in consideration of structural conditions and interferences with other trades or by terminal locations on apparatus.

K. The right is reserved to make reasonable changes in locations of equipment indicated in Drawings prior to installation without an increase in the contract cost.

L. The drawings and specifications do not undertake to indicate every item required to produce a complete and properly operating installation. Material, equipment or labor not indicated, but which can be reasonably inferred to be necessary for a complete installation shall be provided.

2.5 CUTTING AND PATCHING

A. Every effort shall be made to build-in the work as the job progresses. As required, cutting and patching for the installation of sleeves, conduits, equipment, etc., shall be coordinated with the General Contractor. Do not cut any structural element without written permission from the Structural Engineer.
2.6 EQUIPMENT CONNECTIONS
   A. The contractor shall make final connection of all required services to all equipment items furnished, including that provided by others or by the owner. Equipment shall be left in a ready to operate state.

2.7 FLASHING AND WATERPROOFING
   A. Any building penetrations to outside shall be flashed, as required, to prevent leaks.

END OF SECTION 260000
PART 1 - GENERAL

1.1 SCOPE

A. Work of this section includes specification of the following:
   - Wire and connectors.
   - Wiring and control devices.
   - Firestopping.
   - Cutting and patching for electrical construction.
   - Touchup painting.

1.2 QUALITY ASSURANCE

A. Provide electrical components, devices, and accessories specified in this section that are UL listed and labeled as defined in NFPA 70, Article 100.

B. The materials and methods used for all electrical components, devices, and accessories specified in this section shall comply with NFPA 70.

1.3 COORDINATION

A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

C. Coordinate electrical service connections to components furnished by utility companies.

1. Coordinate installation and connection of exterior underground utilities and services, including provision for electricity-metering components.
2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.

D. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.

E. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

F. Verify characteristics, sizes, and ratings, of motors actually supplied prior to providing starter, overload protection and branch circuit wiring.
2.1 **CONDUCTORS**

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

1. **Wire/Cable**
   a. Anaconda
   b. American Wire and Cable
   c. Southwire
   d. Okonite Company

2. **Wire/Cable Connectors**
   - **Split-Bolt Connectors**
     a. Appleton
     b. Crouse-Hinds
     c. Teledyne
   - **Solderless Pressure Connectors**
     a. Burndy
     b. Thomas and Betts
     c. AMP
   - **Spring Wire Connectors**
     a. Burndy
     b. Thomas and Betts
     c. Teledyne
   - **Compression Connectors**
     a. Burndy
     b. Crouse-Hinds
     c. Teledyne

B. **All wire sizes specified shall be i.a.w. American Wire Gauge (AWG) designations.**

C. **Conductors, No. 10 awg and smaller shall be solid or stranded copper. Larger than 10 awg shall be stranded copper. Copper clad conductors are not permitted.**

D. **Conductors shall be copper with not less than 95% conductivity.**

E. **Insulation for power conductors shall be type THW or THHN, rated 600 volts, rated 75 deg. C minimum. Conductor insulation for feeders size 1/0 and larger may be type RHW moisture and heat resistant rubber. Conductor insulation shall have the manufacturers name, type insulation and conductor size imprinted on the jacket at regular intervals. Branch circuit conductors sizes #6 awg and smaller may be type TW. For conductors wired in fluorescent light fixture cable runs use type RHH or THHN insulation rated 90 deg. C.**

F. **Conductor phasing shall be as follows. From left to right, the first bus in each panel shall be Phase ‘A’, middle bus ‘B’, and right bus ‘C’.**

G. **Insulation shall be color coded as required by NFPA 70, 210-5. Color coding shall be consistent throughout the project. Use white conductors only for circuit neutrals. When unable to provide a white conductor, the neutral shall be identified at switches, panelboards, junction boxes, etc. with**
white tape or paint. Equipment grounds shall be green. Isolated equipment grounds shall be green with yellow stripe.

H. All materials used for wire connections and splices shall be of the size, ampacity, material type, and class suitable for the service.

I. Provide wire and cable terminations made with UL-listed one-piece, compression deforming type, solderless high conductivity copper or copper alloy terminal lugs as follows:
   1. Terminal lugs shall have hole sizes and spacing i.a.w. NEMA standards.
   2. Terminal lugs on wire sizes 3/0 and smaller shall be single hole, single compression type. Wire and cable No. 6 AWG and smaller may be terminated on mechanical type connections or terminal strips integral with the equipment or wiring device. The mechanical connector and terminal strip shall be UL-listed copper, either tubular type with a pressure plate or screw type with a wire clamp. The screw shall not directly compress the conductors.
   3. Terminal lugs for use on wire sizes 4/0 and larger shall be two-hole, long barrel, double compression type.

J. In general, there shall be no splices from the power source to the load without written approval from the Engineer. If written approval is given, provide splices and taps which are made with solderless copper compression deforming connectors and which bear the UL label. All splices and taps shall be made in accordance with the manufacturer’s written instructions.
   1. A solid barrel crimped connector shall be used for splices and taps on wire sizes No. 8 AWG and smaller.
   2. A solid barrel compression connector or bolting solid barrel terminal lugs shall be used for splices and taps on wire sizes No. 6 AWG and larger.

K. Connection to motors, solenoids and other devices with integral leads sized No. 4 AWG and smaller (including all current transformers) shall be made with ring-type pressure connectors. Provide connectors bolted together and taped with oil-resistant electrical tape. Soldered or insulation piercing type connectors shall not be used. No connection shall be inside a conduit fitting.

2.2 UTILITY COMPANY METERING

A. Where required, current-transformer cabinets shall comply with the requirements of electrical power utility company. Meter base is to be furnished by the utility company. Verify all metering requirements with the providing utility prior to bid.

2.3 TOUCHUP PAINT

A. Equipment touch-up paint shall be selected to match the installed equipment finish. For galvanized surfaces, a zinc-rich paint recommended by the equipment manufacturer shall be used.

PART 3 - EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Materials and components shall be installed level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
B. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

C. Where wire and cable routing is not shown, and destination only is indicated, determine exact routing and lengths required. Wire and cable routing indicated on the Drawings is approximate unless dimensioned. Route wire and cable as required to meet Project Conditions.

D. Branch circuit wiring is generally sized not to exceed a two-percent voltage drop, but in no case shall exceed a three-percent voltage drop.

3.2 WIRING INSTALLATION

A. Install wiring in a conduit raceway with conductors of the types and sizes as shown on the drawings and specified in these specifications. Where no type or size is given install conductors as required by code.

B. From panels extend a complete system of wiring to all fixtures, motors, devices, and other equipment. Employ multi-wire circuits as indicated. Connect circuits to panelboards to give an evenly balanced load. Secure approval for any departure from the circuit arrangement as shown.

C. Numerals shown on the drawing “home-runs” indicate the circuit arrangement. Cross marks on branch circuit runs indicate the number of conductors required. Where no cross marks are shown, two conductors are indicated.

D. All home runs shall be 12 (twelve) awg or larger as indicated. Provide 10 (ten) awg where home runs exceed 60 feet in length. No wire smaller than #12 is permitted serving lighting or outlets.

E. Do not pull conductors until the entire conduit system is complete and the building is “in the dry”. Use only UL approved lubricants to facilitate conductor pulling.

F. Furnish all switches, connections, branch circuits, wiring, etc. to HVAC equipment, as needed, to provide a complete power wiring system. Install and connect 120 Vac control devices which are to be included in power wiring.

G. Furnish raceway, backboxes, wiring, connections, etc. for all equipment and systems furnished under this or other section(s) of these specifications, or by Owner, for a complete installation i.a.w. suppliers and manufacturers instructions. All equipment shall be connected ready for operation, i.a.w. detailed wiring diagrams furnished by the equipment manufacturer and in cooperation with the respective subcontractor or Owner. Provide receptacles to match equipment furnished plugs.

H. Install wiring at outlets with a minimum of 8" of slack conductor.

I. Install pre-finished cord sets where connection with an attachment plug is indicated or specified, or use attachment plug with suitable strain relief clamps.

J. Solderless pressure connectors with insulating covers shall be used for copper conductor splices and taps, No. 8 awg and smaller.

K. Insulation on approved splices and taps for wire sizes No. 8 AWG and smaller shall consist of:
   1. Half-lapped layers of all weather pvc tape installed to a thickness equivalent to the conductor insulation. Or
   2. An insulation system consisting of a heat shrink or cold shrink system properly sized for the application.
L. Insulation on approved splices and taps for wire sizes No. 6 AWG and larger shall consist of:

1. A minimum of three half-lapped layers of yellow, varnished cambric tape and three half-lapped layers of all weather pvc tape. An electrically insulating putty may be used over irregular shapes prior to application of the tape.

2. An insulation system consisting of a heat shrink or cold shrink system properly sized for the application.

3.3 IDENTIFICATION MATERIALS AND DEVICES

A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

C. Clean surfaces before applying self-adhesive identification products.

D. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.

E. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 6 to 8 inches below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches, overall, use a single line marker.

F. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

G. Panel schedules for existing branch circuit panel boards shall be updated for all circuit changes.

H. All enclosures containing 480 volt circuit conductors shall be clearly labeled with a “Danger - 480 Volts” warning sign.

I. Label raceway branch circuit junction boxes as to the panel(s) and circuit number(s) from which the circuit(s) originates. Use machine printed, pressure sensitive, abrasion resistant label tape on the faceplate and wiremarkers or tags within the box.

J. Provide engraved nameplates to identify all electrical distribution and control equipment and loads served. Letter height shall be 1/8 inch for individual switches and loads served, 1/4 inch for distribution and control equipment identification.

K. Panelboards, switchboards and motor control centers shall have 1/4 inch letter engraved nameplates to identify with the equipment designation, 1/8 inch lettering to identify the voltage rating and source.

L. Provide an engraved nameplate with 1/8 lettering to identify the conductor color coding scheme at each panelboard and switchboard. Mount on the interior of the door if so equipped, otherwise on the back of the trim.
3.4 UTILITY COMPANY EQUIPMENT
   A. Install equipment according to utility company’s requirements. Provide grounding and empty
      conduits as required by utility company.

3.5 FIRESTOPPING
   A. Penetrations of fire rated floor and wall assemblies shall be sealed with firestop material appropriate
      to achieve the designated fire resistance rating of the assembly. Firestopping materials and
      installation requirements are specified in Division 7.

3.6 CUTTING AND PATCHING
   A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit
      electrical installations. Perform cutting by skilled mechanics of trades involved.
   B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed
      surfaces. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.7 REFINISHING AND TOUCHUP PAINTING
   A. The following procedure should be used for refinishing and/or touch-up needed:
      1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit
         the degree of damage at each location.
      2. Follow paint manufacturer's written instructions for surface preparation and for timing and
         application of successive coats.
      3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
      4. Repair damage to PVC or paint finishes with matching touchup coating recommended by
         manufacturer.

END OF SECTION 260500
SECTION 260526 - GROUNDING & BONDING

PART 1 - GENERAL

1.1 SCOPE

A. This Section includes grounding of electrical systems and equipment and basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other Sections of these Specifications.

1.2 RELATED DOCUMENTS

A. Referenced standards include:
   - NFPA 70 - National Electric Code
   - OSHA 1910 - Standards for General Industry

1.3 QUALITY ASSURANCE

A. Provide electrical components, devices, and accessories specified in this section that are UL listed and labeled as defined in NFPA 70, Article 100.
B. Grounding rod resistance shall be 10 ohms or less.
C. Grounding system to be tested i.a.w. ANSI/IEEE Std 81 using the “two-point” method.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Rod Electrode
   a. A.B. Chance
   b. Copperweld Bimetallics Div
   c. National Ground Rod

2. Mechanical Connectors
   a. O.Z. Gedney
   b. Burndy
   c. Thomas & Betts, Electrical

3. Exothermic Connections
   a. Caldweld
   b. Thermoweld
2.2 GROUNDING AND BONDING PRODUCTS
   A. Where types, sizes, ratings, and quantities indicated are in excess of National Electrical Code (NEC) requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

2.3 WIRE AND CABLE GROUNDING CONDUCTORS
   A. Wire and cable grounding conductors shall conform to NEC Table 8, except as otherwise indicated.
   B. All equipment grounding conductors shall be insulated with green color insulation.
   C. Grounding-electrode conductors shall be stranded copper cable.

2.4 MISCELLANEOUS CONDUCTORS
   A. Where required, braided bonding jumpers shall be a copper tape, braided No. 30 AWG bare copper wire, terminated with copper ferrules. Bonding straps shall be soft copper, 0.05 inch thick and 2 (two) inches wide.

2.5 CONNECTOR PRODUCTS
   A. Pressure type connectors shall be of a high-conductivity-plated design.
   B. Bolted Clamps shall be heavy-duty type.
   C. Exothermic-welded connections shall be as provided in kit form and selected per manufacturer's written instructions for specific types, sizes, and combinations of conductors and connected items.

2.6 GROUNDING ELECTRODES
   A. Grounding rods shall be a copper-clad steel of the size indicated on the drawings.

PART 3 - EXECUTION

3.1 APPLICATION
   A. Equipment grounding conductors shall be installed to comply with NEC Article 250. Where types, sizes, and quantities of equipment grounding conductors, are more than required by NEC use the more stringent requirements.
      1. Install insulated equipment grounding conductor with circuit conductors for the items below in addition to those required by Code:
         a. Feeders and branch circuits.
         b. Lighting circuits.
         c. Receptacle circuits.
         d. Flexible raceway runs.
         e. Armored and metal-clad cable runs.
         f. Single phase motor or appliance branch circuits.
         g. Three phase motor or appliance branch circuits.
2. Install a separate equipment grounding conductor to each electric water heater, heat-tracing assembly, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

3. Ground metal pole supporting outdoor lighting fixture to a grounding electrode in addition to separate equipment grounding conductor run with supply branch circuit.

B. Exothermic welded connections shall be used for all underground connections or connections to structural steel.

C. Equipment grounding conductor connections will be made with bolted pressure clamps.

D. Install an insulated equipment grounding conductor connected to the receptacle grounding terminal for all isolated grounding receptacle circuits. Isolate grounding conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. As noted on the plans, for designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate equipment grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

F. Install an equipment grounding conductor to air duct-mounted electrical devices operating at 120 V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.

G. Provide grounding and installation for telephone equipment i.a.w., NFPA 70, Section 800.

3.2 INSTALLATION

A. Ground electrical systems and equipment according to NEC requirements, except where Drawings or Specifications exceed NEC requirements.

1. Drive ground rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated. Verify that final backfill and compaction has been completed prior to driving ground rods.

2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.

B. Grounding conductors shall be routed along the shortest and straightest paths possible, except as otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

C. For underground grounding conductors, use bare copper wire buried at least 24 inches below grade.

D. Provide insulated copper grounding conductors, in conduit, from building’s main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end. Use braided-type bonding jumpers to electrically bypass water meters.
3.3 CONNECTIONS

A. Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.

1. Use electroplated or hot-tin-coated materials to assure high conductivity and to make contact points closer in order of galvanic series.
2. Make connections with clean, bare metal at points of contact.

B. Use exothermic-welded connections for connections to structural steel and for underground connections. Comply with manufacturer’s written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

C. Equipment grounding-wire terminations for No. 8 awg and larger, use pressure-type grounding lugs. No. 10 awg and smaller grounding conductors may be terminated with winged pressure-type connectors.

1. Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.

D. Where metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at both entrances and exits with grounding bushings and bare grounding conductors, except as otherwise indicated.

E. Where insulated grounding conductors are connected to grounding rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

F. Measure the ground resistance of each rod. A maximum of 10 ohms, unless otherwise indicated, or less to be provided. If ground resistance is not 10 ohms or less, drive additional rods to obtain the required resistance. Paralleled ground rod spacing shall be as recommended in IEEE 142, Grounding of Industrial and Commercial Power Systems.

G. All test and measurement data shall be provided to the Engineer for review.

END OF SECTION 260526
PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.2 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. IMC: Intermediate metal conduit.
C. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

1.5 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.
PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.; a division of Cooper Industries.
   c. Thomas & Betts Corporation.
   d. Unistrut; Tyco International, Ltd.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.

2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1) Cooper B-Line, Inc.; a division of Cooper Industries.
2) Hilti Inc.
3) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.

PART 3 - EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.
2. To New Concrete: Bolt to concrete inserts.
3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
4. To Existing Concrete: Expansion anchor fasteners.
5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69
7. To Light Steel: Sheet metal screws.
8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 CONCRETE BASES
A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in other sections of these specifications.
C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.4 PAINTING
A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529
PART 1 - GENERAL

1.1 SCOPE

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1. Raceways include the following:
   a. EMT - Electrical Metallic Tubing
   b. FMC - Flexible Metal Conduit
   c. LFMC - Liquid Tight Flexible Metal Conduit
   d. PVC - PVC coated, Rigid Steel Conduit
   e. RNC - Rigid Non-metallic Conduit
   f. RSG - Rigid Steel Galvanized Conduit

2. Boxes, enclosures, and cabinets include the following:
   a. Device boxes.
   b. Floor boxes.
   c. Outlet boxes.
   d. Pull and junction boxes.
   e. Cabinets and hinged-cover enclosures.

1.2 RELATED DOCUMENTS

A. Referenced standards include:
   NFPA 70 - National Electric Code
   ANSI C80.1 - American National Standard, Rigid Steel Galvanized Conduit
   ANSI C80.3 - American National Standard, Electrical Metallic Tubing
   OSHA 1910 - Standards for General Industry
   NEMA FB1 - National Electrical Manufacturers Assoc., fittings
   NEMA TC 3 - PVC fittings

1.3 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

B. Field verify measurements.

C. Verify routing and termination locations of conduit prior to rough-in.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. **Metal Conduit and Tubing:**
   a. Allied Tube and Conduit
   b. Triangle
   c. Wheatland
   d. Anaconda (flexible conduit)

2. **Nonmetallic Conduit and Tubing:**
   a. Carlon
   b. Robroy
   c. Anaconda

3. **Conduit Bodies and Fittings:**
   a. Crouse-Hinds
   b. Appleton
   c. O-Z/Gedney

4. **Fire Rated Fittings:**
   a. Crouse-Hinds
   b. O-Z/Gedney
   c. Appleton

5. **Expansion/Deflection Fittings:**
   a. Crouse-Hinds
   b. O-Z/Gedney
   c. Appleton

6. **Boxes, Enclosures, and Cabinets:**
   a. Crouse-Hinds
   b. Hoffman
   c. B-Line
   d. Robroy

2.2 **METAL CONDUIT AND TUBING**

A. **EMT and Fittings**

   1. All electrical metallic tubing shall comply with the latest revision of ANSI C80.3.

   2. Electrical metallic tubing (EMT) shall be galvanized steel and shall be used for all indoor concealed or exposed work, unless otherwise noted. Connectors and couplings shall be threadless compression type.

B. **FMC**

   1. Flexible metal conduit shall be used for final connections to motors. Conduit shall be of an interlocked steel construction.

C. **LFMC**

   1. Liquid tight flexible metal conduit shall be used in wet locations for final connections to motors and other equipment subject to vibration. Preference given to neoprene jacketed “Seal-lite” by Anaconda or equal.
D. PVC

1. PVC coated rigid steel conduit shall be used for all transitions from below grade to 18 (eighteen) inches above the finished grade or floor.

E. RSG

1. All rigid steel galvanized conduit shall comply with the latest revision of ANSI C80.1.

2. Rigid steel galvanized conduit shall be used for all exterior exposed work, unless otherwise noted. Rigid steel galvanized conduit shall be used in all NEC, classified, hazardous locations whether interior or exterior.

F. Fittings

1. All fittings shall comply with the requirements of NEMA FB 1, standard for conduit fittings, cast metal boxes, and conduit bodies. All fittings used shall be compatible with the conduit and tubing materials used.

2.3 NONMETALLIC CONDUIT

A. RNC

1. Unless otherwise noted, all rigid nonmetallic conduit shall be schedule 40 PVC complying with NEMA TC 3 standards.

2. RNC shall be used for underground cable runs, unless otherwise noted. Provide schedule 80 PVC where underneath roadways and drives subject to vehicle traffic.

B. Fittings

1. Unless otherwise noted, all fittings used with nonmetallic conduit shall be schedule 40 PVC complying with NEMA TC 3 standards. The fittings used shall be compatible with conduit size and type.

2.4 OUTLET AND DEVICE BOXES

A. Metal Boxes

1. Provide galvanized steel metal boxes sized to accommodate devices and conductors as per NEC Art. 370 at each outlet location indicated on the drawings or as required. Boxes shall be a minimum of 1.5" deep, of metal a minimum of 1/16" thick.

2. Boxes used with exposed conduit should be a four inch square utility box.

3. The owner reserves the right to make adjustments to the location of outlet boxes prior to rough-in.

4. Sizes and configuration of boxes shall be as required for the intended service. The boxes shall conform to and be applied, i.a.w, NEC requirements. Supports, gaskets, extension rings, etc. shall be provided where required.

5. Gang type boxes shall be used where multiple wiring devices are located together.
B. Floor Boxes

1. Floor boxes shall be located as indicated on the drawings. Coordinate with architect/owner prior to final placement. A multi-function floor box, providing completely segregated power and data cabling and outlets, shall be used where power and communications outlets are shown in the same general location, even when the outlets are shown on different electrical plan sheets.

2. Nonmetallic boxes suitable for concrete encasement may be used.

3. Boxes equal to Wiremold 880MP, rectangular, series, with separate, stainless steel, flip lid, cover plates.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

B. Minimum Raceway Size: 1/2-inch trade size. Homers shall be 3/4" minimum.

C. Conceal conduit and EMT, unless otherwise indicated, within finished walls, ceilings, and floors, except in equipment room. Do not run conduit in cavity of exterior wall.

D. Keep raceways at least 12 inches away from hot-water pipes. Install horizontal raceway runs above water piping.

E. Install raceways level and square and at proper elevations. Provide adequate headroom.

F. Complete raceway installation before starting conductor installation.

G. All conduits, concealed or exposed, shall be supported and substantially fastened to structural members at intervals of not more than 8 (eight) feet. Attach supporting devices with screws, bolts, expansion sleeves or other workmanlike means appropriate to the surface. Boxes which are not embedded in masonry or concrete shall be fastened to the structure in the same manner as for conduits.

H. Use temporary closures to prevent foreign matter from entering raceways.

I. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab. Where conduits emerge from the ground or slab, provide a rigid steel adapter, elbow and conduit. Slope conduits to drain away from the building. All metal conduits installed underground shall be PVC coated. PVC coated rigid steel conduit shall be used within five feet from foundation walls.
J. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated.

K. Use raceway fittings compatible with raceways and suitable for use and location.

L. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.

M. Raceways Embedded in Slabs: Install in middle third of slab thickness where practical, and leave at least 1-inch concrete cover.
   1. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
   2. Space raceways laterally to prevent voids in concrete.
   3. Run conduit larger than 1-inch trade size parallel to or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
   4. Transition from nonmetallic tubing to rigid steel conduit before rising above floor.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
   1. Run parallel or banked raceways together, on common supports where practical.
   2. Make bends in parallel or banked runs from same centerline. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.

O. Join raceways with fittings designed and approved for the purpose and make joints tight.
   1. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
   2. Use insulating bushings to protect conductors.

P. Terminations: Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box. Provide bushings on ends where auxiliary system conduit raceway is stubbed out into furred space, adjacent to backboard, etc.

Q. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.

R. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of the pull wire.

S. Telephone and Signal System Raceways, 2-Inch Trade Size and Smaller: In addition to the above requirements, install raceways in maximum lengths of 150 feet and with a maximum of two 90-degree bends or equivalent. Separate lengths with pull or junction boxes where necessary to comply with these requirements.

T. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with the finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches above the floor. Install screwdriver-operated, threaded flush plugs flush with floor for future equipment connections.
U. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

V. Set floor boxes level and trim after installation to fit flush to finished floor surface.

W. Provide galvanized sheet metal pull boxes with screw type cover, as required, to avoid excessive runs or bends between outlets.

X. Grade all raceway away from service entrance equipment to prevent water damage.

Y. Provide expansion fittings in all conduits crossing an expansion joint. Fitting shall be OZ type “EX” for rigid metal conduit or schedule 40 PVC. Fitting shall be OZ type “TX” for EMT. Metallic conduit not containing a grounding conductor shall have OZ type “BJ” bonding jumpers installed across expansion joints. Provide expansion fittings for PVC conduit runs over 150 feet, or outdoors or in areas or runs subject to temperature variations over 75 degrees F, and as recommended by the manufacturer.

Z. Grouped raceways shall be supported with galvanized steel channel assemblies equal to Kindorf B-909 and single bolt straps equal to Kindorf C-105. Raceway supports shall be spaced within 2 (two) feet of termination and/or connection and 8 (eight) feet on center for rigid steel, and EMT conduit. RNC shall be supported i.a.w. NFPA 70, 347-8. FNMC shall be supported within 12 (twelve) inches of termination/connection and 4.5 (four and one-half) feet on center.

AA. The drawings indicate approximate locations only. Determine the exact location on site in consideration of all structural and architectural conditions.

BB. Provide and install “low point drains” in all above grade, outdoor raceway. Provide and install breather drains in the bottom of outdoor control panels. As much as possible, route conduits into the bottom of control panels.

CC. All phase conductors and, where used, the grounded conductor, and all equipment grounding conductors shall be grouped together in a single raceway. Where multiple phase conductors are run in parallel, separate conduits shall be run to contain one set of all phase conductors, neutral (if used) and the equipment grounding conductor.

DD. Where underground conduits stub-up through concrete equipment pad “blocked out” windows, after curing blocks, fill the block-out window with gravel to 1” of the top and cap with mortar. Caulk all entrances and around the mortar.

3.3 PROTECTION

A. Provide final protection and maintain conditions, in a manner that ensures coatings, finishes, and cabinets are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.
3.4 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION 260533
SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
5. Warning labels and signs.
7. Miscellaneous identification products.

1.2 QUALITY ASSURANCE
A. Comply with NFPA 70.
C. Comply with ANSI Z535.4 for safety signs and labels.
D. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.3 COORDINATION
A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS
A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
B. Colors for Raceways Carrying Circuits at 600 V or Less:
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

C. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.4 UNDERGROUND-LINE WARNING TAPE

A. Tape:
   1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
   2. Printing on tape shall be permanent and shall not be damaged by burial operations.
   3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:
   1. Comply with ANSI Z535.1 through ANSI Z535.5.
   2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
   3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag: Type ID:
   1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of
the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Overall Thickness: 5 mils (0.125 mm).
3. Foil Core Thickness: 0.35 mil (0.00889 mm).

2.5 WARNING LABELS AND SIGNS
B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
C. Metal-Backed, Butyrate Warning Signs:
   1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
   2. 1/4-inch (6.4-mm) grommets in corners for mounting.
   3. Nominal size, 10 by 14 inches (250 by 360 mm).

2.6 EQUIPMENT IDENTIFICATION LABELS
A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS
A. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION
A. Verify identity of each item before installing identification products.
B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
C. Apply identification devices to surfaces that require finish after completing finish work.
D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below
finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall.

G. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
   
a. Color shall be factory applied.
   b. Colors for 208/120-V Circuits:
      1) Phase A: Black.
      2) Phase B: Red.
      3) Phase C: Blue.
   c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

H. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

J. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels Baked-enamel warning signs.

2. Identify system voltage with black letters on an orange background.
3. Apply to exterior of door, cover, or other access.
4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
   
a. Power transfer switches.
   b. Controls with external control power connections.

K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:
   
a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high
letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be **engraved**, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchboards.

e. Enclosed switches.

f. Contactors.

END OF SECTION 260553
SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY
   A. This Section includes the following lighting control devices:
      1. Time switches.
      2. Photoelectric switches.
      3. Indoor occupancy sensors.
      4. Lighting contactors.

1.2 DEFINITIONS
   A. LED: Light-emitting diode.
   B. PIR: Passive infrared.

1.3 SUBMITTALS
   A. Product Data: For each type of product indicated.
   B. Shop Drawings: Show installation details for occupancy and light-level sensors.
      1. Interconnection diagrams showing field-installed wiring.
   C. Field quality-control test reports.
   D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE
   A. Electrical Components, Devices, and Accessories: UL listed and labeled as defined in NFPA 70, Article 100, and marked for intended use.

1.5 COORDINATION
   A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.
PART 2 - PRODUCTS

2.1 TIME SWITCHES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Intermatic, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Paragon Electric Co.; Invensys Climate Controls.
   6. Square D; Schneider Electric.
   7. TORK.

B. Electronic Time Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
   1. Contact Configuration: DPDT
   2. Contact Rating: 30-A inductive or resistive, 240-V ac or as otherwise noted on the plans.
   3. Program: 2 on-off set points on a 24-hour schedule, allowing different set points for each day of the week and an annual holiday schedule that overrides the weekly operation on holidays.
   4. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program.
   5. Astronomic Time: All channels.
   6. Battery Backup: For schedules and time clock.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Area Lighting Research, Inc.; Tyco Electronics.
   2. Grasslin Controls Corporation; a GE Industrial Systems Company.
   3. Intermatic, Inc.
   4. Lithonia Lighting; Acuity Lighting Group, Inc.
   5. Novitas, Inc.
   7. Square D; Schneider Electric.
   8. TORK.

B. Description: Solid state, with DPST dry contacts rated to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.
   1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
   2. Time Delay: 15-second minimum, to prevent false operation.
   4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
2.3 INDOOR OCCUPANCY SENSORS

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

1. Hubbell Lighting.
3. Lithonia Lighting; Acuity Lighting Group, Inc.
4. Novitas, Inc.
5. Sensor Switch, Inc.
6. TORK.

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
4. Mounting:
   a. Sensor: Suitable for mounting in any position on a standard outlet box.
   b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
   c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.
7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Corridor): Detect occupancy within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling.

D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. (56 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. (186 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.
5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet (27.4 m) when mounted on a 10-foot- (3-m-) high ceiling in a corridor not wider than 14 feet (4.3 m).

E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.
2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).
3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.4 LIGHTING CONTACTORS

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

2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
4. GE Industrial Systems; Total Lighting Control.
5. Hubbell Lighting.
6. Lithonia Lighting; Acuity Lighting Group, Inc.
7. Square D; Schneider Electric.

B. Description: Electrically operated and mechanically held, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
3. Enclosure: Comply with NEMA 250.
4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
PART 3 - EXECUTION

3.1 SENSOR INSTALLATION
A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION
A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION
A. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
B. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.
C. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION
A. Identify components and power and control wiring.
   1. Identify controlled circuits in lighting contactors.
   2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.
B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL
A. Perform the following field tests and inspections and prepare test reports:
   1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
   2. Operational Test: Verify operation of each lighting control device, and adjust time delays.
B. Lighting control devices that fail tests and inspections are defective work.
3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

END OF SECTION 260923
SECTION 262416 - PANELBOARD

PART 1 - GENERAL

1.1 SCOPE

1. This Section includes lighting and power panelboards and associated auxiliary equipment rated 600 V and less for the following types:

   - Lighting and appliance branch - circuit panelboards
   - Distribution panelboards

1.2 SUBMITTALS

1. Submit product data for each type of panelboard, accessory item, and component specified.

2. Submit shop drawings for panelboards. Include dimensioned plans, sections, and elevations. Show tabulations of installed devices, major features, and voltage rating. Include the following:
   1. Enclosure type with details.
   2. Bus configuration and current ratings.
   4. Features, characteristics, ratings, and factory settings of individual protective devices and auxiliary components.
   5. Wiring Diagrams: Details of schematic diagram including control wiring and differentiating between manufacturer-installed and field-installed wiring.

3. Submit panelboard schedules for installed panelboards after load balancing.

1.3 QUALITY ASSURANCE

1. Provide products specified in this Section that are UL listed and labeled as defined in NFPA 70, Article 100.

2. Acceptable manufacturers shall be companies regularly engaged in the design, manufacture, and testing of panelboards for electrical use and shall have been producing such products for at least five (5) years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Acceptable manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Cutler-Hammer
   2. General Electric
   3. Square D
   4. Siemens
2.2 PANELBOARD FABRICATION

   1) Rated for environmental conditions at installed location.
      a) Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b) Outdoor Locations: NEMA 250, Type 3R.
      c) Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      d) Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   2) Front: Dead front, secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
   3) Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
   4) Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
   5) Finishes:
      a) Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer’s standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
      b) Back Boxes: Steel. Same finish as panels and trim.

2. The directory frame shall be metal with a transparent protective cover, mounted inside each panelboard door.

3. The panelboard bus shall be hard drawn copper of 98 percent conductivity with compression type main and neutral lugs. Panelboard shall have a full-capacity neutral bus.

4. The equipment ground bus will be adequate for feeder and branch-circuit equipment ground conductors and be bonded to the box.

5. Unless otherwise noted or indicated on the drawings, only panelboards listed as approved for service entrance equipment use with a main disconnect shall be used as a service entrance panel.

6. Minimum rating of panelboards shall be 10,000 AIC rms sym. Refer to the drawings for higher rating requirements. Refer to the drawings for panel bus ratings.

7. Panelboards shall have provisions for at least the number of branch-circuits as indicated on the drawing panel schedules. Circuits will be filled with circuit breakers, at least, as indicated on the panel schedule.

8. The panelboard box shall be fabricated of code gauge, galvanized sheet steel i.a.w. UL standards. The box shall have standard knockouts on the enclosure.

9. The front shall be fabricated of sheet steel and finished with a baked on gray enamel over a rust inhibitor. Panelboards shall have a full hinged cover. Doors shall have flush type cylinder locks and catches. Panelboard locks shall be master keyed, with two keys furnished for each panelboard.

10. Incoming mains location: Top and bottom.
11. Conductor Connectors: Suitable for use with conductor material and sizes.
   (i) Material: Hard-drawn copper, 98 percent conductivity.
   (ii) Main and Neutral Lugs: Compression type.
   (iii) Ground Lugs and Bus-Configured Terminators: Compression type.
   (iv) Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
   (v) Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
   (vi) Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

2.3 CIRCUIT BREAKERS

1. Circuit breakers shall be bolt-on type full module, with quick-make and quick-break toggle action mechanism. Trip indication shall be shown by breaker handle taking position between on and off. All multiple pole services shall be common trip with a single handle. Circuit breakers shall be replaceable without disturbing adjacent units.

2. Circuit breakers shall be fully rated with an interrupting rating equal to that of the panelboard to which they are installed.

3. Circuit breakers will be of the same manufacturer as the panelboard installed.

4. Circuit breakers shall have mechanical compression connections.

5. Single pole circuit breakers serving fluorescent lighting loads shall have the SWD marking.

6. Circuit breakers serving air conditioning branch loads shall be UL listed as HACR type.

7. All circuit breakers shall be of the same manufacturer as the panelboard to which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

1. Panelboards shall be installed at 90 inches above finished floor to the top of the trim, unless otherwise indicated.

2. Panelboards shall be mounted plumb and rigid without distortion of box. Mount flush panelboards uniformly flush with wall finish.

3. Type the circuit directory to indicate installed circuit loads after balancing panelboard loads. Install the typed directory in the panelboard.

4. Install filler plates in unused spaces.

5. Wiring shall be neatly arranged in panelboard gutters.

6. For flush mount panelboards, stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
7. Set field-adjustable circuit breaker trip ranges.

3.2 IDENTIFICATION

1. Label each panelboard with engraved laminated-plastic or metal nameplates mounted with corrosion-resistant screws.

3.3 GROUNDING

1. Make equipment grounding connections for panelboards as indicated, i.a.w, NEC. Provide ground continuity to main electrical ground bus.

3.4 CONNECTIONS

1. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.5 TESTING

1. Make insulation-resistance tests of each panelboard bus, component, and connecting supply, feeder, and control circuits.

   Panelboard bus insulation tests shall consist of a 1000 volt “megger” test, phase-to-phase and each phase-to-ground, each test shall be held for a minimum of one minute. Minimum acceptable insulation resistance shall be 500 megohms. Test results shall be corrected for temperature deviations from a 20 deg C standard. Provide test results to Owner and Engineer.

2. Make continuity tests of each circuit.

3. Measure steady-state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase load within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262416
SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SCOPE

A. Work of this section includes specification of the following:
   1. Receptacles
   2. Switches
   3. Wall Plates

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Wiring Devices:
      a. Arrow
      b. Hubbell
      c. Leviton

2.2 RECEPTACLES

A. Receptacles shall be specification grade, duplex type, rated 20 amp, 120 volt service, unless otherwise noted. Receptacles shall be of the straight-blade design, NEMA configuration 5-20R. Receptacles of critical branch circuits shall be red.

   Hubbell 5351, Arrow-Hart 5351, or Leviton 5351: 125 V single convenience receptacle
   Hubbell 5352, Arrow-Hart 5352, or Leviton 5352: 125 V duplex convenience receptacle

B. GFCI receptacles may be a feed-through, as needed to protect downstream receptacles on the same circuit. The duplex receptacle configuration shall be NEMA 5-20R. Weatherproof enclosures shall be provided as indicated on the drawings. Receptacle shall have an integral ground fault circuit interrupter.

   Hubbell GF5362, Arrow-Hart GF5342, or Leviton 6899: 125 V GFCI duplex receptacle.

C. All receptacles shall have plaster ears and grounding straps.

D. Unless otherwise noted by Owner and/or Architect, all receptacles shall be white in color with white cover plate. Each like receptacle on the project shall be of the same manufacturer and catalog number.

E. All floor plates shall be stainless steel with a stainless steel finish.

2.3 SWITCHES

A. All toggle switches will be specification grade, quiet type snap switches, rated for 20 amp, 120/277 volt service. At a minimum, side screw terminals shall be provided.


B. Unless otherwise noted by Owner and/or Architect, all switches shall be white in color with white cover plate. Each like switch on the project shall be of the same manufacturer and catalog number.

C. Fluorescent dimmer switches shall be compatible with dimmer ballast. Dimmer/Ballast combination shall be capable of consistent dimming down to no more than 5% of full brightness.

2.4 WALL PLATES

A. Single, gang, and combination type wall plates will be used as needed with each corresponding wiring device.

B. Each wall plate will be of a matching color to the wiring device attached. The plate will be secured with metal, matching color headed screws. Provide stainless steel plate unless otherwise noted by Owner and/or Architect.

C. Where weatherproof devices are noted, provide IN-USE type with clear cover. Equal to Pass & Seymour WIUC10-CL (for single gang applications)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all wiring devices and assemblies plumb and secure.

B. Install all wall plates when painting is complete.

C. Install all wiring devices by connection to screw terminals only. Connection to pressure terminals is not acceptable.

D. Use single plates of proper gang where more than one device occurs. Furnish blank plates on outlets for future use.

E. Unless otherwise noted, install wall devices vertically so that all devices of any given height will exactly align. Plates must be plumb and true with all four edges in continuous contact with the wall surface. Do not install devices until plastering or other wall covering work is complete.

F. Protect wiring devices during painting.

G. Wiring devices and other equipment shall, unless otherwise noted, be mounted with respect to indicated surfaces as follows: Note – verify all device mounting heights with Architect prior to rough-in. Architectural/ADA requirements take precedence over that given here in the event of any discrepancies.

   Receptacles: 18" AFF or 6" above working surface  
   Switches: 4'6" AFF or as otherwise required for ADA compliance  
   Telephone outlets: same as receptacles  
   Computer network outlets: same as receptacles  
   Thermostats: 5'0" AFF or as otherwise required for ADA compliance

H. Wiring device grounding terminals shall be connected to the branch-circuit equipment grounding conductor.
I. GFCI receptacles will be functionally tested according to the manufacturer’s instructions. Record of the test shall be provided to the owner.

J. Install all switches with the “OFF” position down.

K. Install receptacles with grounding pole on top.

L. Coordinate exact location of all wiring devices with owner/architect prior to rough-in.

END OF SECTION 262726
SECTION 262816 - DISCONNECT SWITCHES

PART 1 - GENERAL

1.1 SCOPE

A. This Section includes individually mounted switches used as an equipment disconnect.

1.2 RELATED DOCUMENTS

A. Referenced standards include:

- NFPA 70 - National Electric Code
- OSHA 1910 - Standards For General Industry
- ANSI/UL 198C - High-Intensity Capacity Fuses: Current Limiting Types
- ANSI/UL 198E - Class R Fuses

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering disconnect switches and circuit breakers that may be incorporated into the Work include, but are not limited to, the following:

1. Molded Case Circuit Breaker:
   a. General Electric
   b. Square D
   c. Cutler-Hammer
   d. Siemens

2. Fusible Switches:
   a. General Electric
   b. Square D
   c. Cutler-Hammer
   d. Siemens

2.2 DISCONNECT SWITCHES

A. Fusible Switch Assemblies: Switch shall be heavy-duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. The handle shall be lockable and interlocked with the cover in the CLOSED position to prevent opening with the switch in the ON position. Fuse clips shall be designed to accept Class R fuses.

B. Non-fusible Switch Assemblies: Switch shall be heavy-duty, quick-make, quick-break load interrupter enclosed knife switch with externally operable handle. The handle shall be lockable and interlocked with the cover in the CLOSED position to prevent opening with the switch in the ON position.

C. Operation of the handle shall disconnect all three poles.
2.3 FUSES

A. Fuses 600 amps and less shall be ANSI/UL 198E, Class RK1, RK5, size as indicated, dual element, current limiting, time delay.

B. Interrupting rating shall be 200,000 amps rms symmetrical.

C. Acceptable manufacturers: Bussman, Gould, Reliance Co.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The location indicated for each disconnect is approximate. Coordinate with the protected equipment’s installer for the exact location. Install i.a.w. manufacturer’s written instructions.

B. Install disconnect switches level and plumb.

C. Install all wiring between disconnect switches, and equipment so as to make a complete and functional installation.

D. Provide grounding i.a.w. NEC requirements.

E. Label the disconnect with the distribution panel name and circuit number feeding the switch. Labeling shall comply with the applicable requirements of Section 260500.

END OF SECTION 262816
SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes:
      1. Interior solid-state luminaires that use LED technology.
      2. Lighting fixture supports.

1.2 DEFINITIONS
   A. CCT: Correlated color temperature.
   B. CRI: Color Rendering Index.
   C. Fixture: See "Luminaire."
   D. IP: International Protection or Ingress Protection Rating.
   E. LED: Light-emitting diode.
   F. Lumen: Measured output of lamp and luminaire, or both.
   G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.3 ACTION SUBMITTALS
   A. Product Data: For each type of product.
      1. Arrange in order of luminaire designation.
      2. Include data on features, accessories, and finishes.
      3. Include physical description and dimensions of luminaires.
      4. Include emergency lighting units, including batteries and chargers.
      5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
         a. Testing Agency Certified Data: For indicated luminaires, photometric data certified
            by a qualified independent testing agency. Photometric data for remaining
            luminaires shall be certified by manufacturer.

1.4 QUALITY ASSURANCE
   A. Provide luminaires from a single manufacturer for each luminaire type.

1.5 DELIVERY, STORAGE, AND HANDLING
   A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering
      before shipping.
1.6  WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1  LUMINAIRE REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Recessed Fixtures: Comply with NEMA LE 4.

C. CRI of minimum 80 CCT of 3500 K.

D. Rated L70 life of 50,000 hours for the entire fixture assembly, including driver.

E. Lamps dimmable from 100 percent to 1 percent of maximum light output.

F. Internal driver.

2.2  MATERIALS

A. Metal Parts:
   1. Free of burrs and sharp corners and edges.
   2. Sheet metal components shall be steel unless otherwise indicated.
   3. Form and support to prevent warping and sagging.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers and Globes:
   1. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
   2. Glass: Annealed crystal glass unless otherwise indicated.
   3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

D. Housings:

E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
   1. Label shall include the following lamp characteristics:
      a. “USE ONLY” and include specific lamp type.
b. Lamp diameter, shape, size, wattage, and coating.
c. CCT and CRI for all luminaires.

2.3 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.4 LUMINAIRE FIXTURE SUPPORT COMPONENTS

A. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.

B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)

C. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before fixture installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Install lamps in each luminaire.

D. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.

E. Flush-Mounted Luminaire Support:
1. Secured to outlet box.
2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
3. Trim ring flush with finished surface.

F. Wall-Mounted Luminaire Support:
   1. [Attached to structural members in walls] [Attached to a minimum 20 gauge backing plate attached to wall structural members] [Attached using through bolts and backing plates on either side of wall] <Insert means of attachment>.
   2. Do not attach luminaires directly to gypsum board.

G. Suspended Luminaire Support:
   2. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and [tubing or rod] [wire support] for suspension for each unit length of luminaire chassis, including one at each end.
   3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.

H. Ceiling-Grid-Mounted Luminaires:
   1. Secure to any required outlet box.
   2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
   3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

   1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
   2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

B. Luminaire will be considered defective if it does not pass operation tests and inspections.

C. Prepare test and inspection reports.

END OF SECTION 265119
SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Cleaning site of debris, grass, trees, and other plant life in preparation for site or building
      earthwork.
   2. Protection of existing structures, trees, or vegetation indicated on the Construction Drawings to
      remain.
B. Related Sections
   1. Section 02 41 13 – Selective Site Demolition: Demolition and removal of structures, paving, utilities
      and other improvements.
   2. Section 31 20 00 – Earthwork: Stripping and removal of topsoil.
   3. Section 31 25 00 – Erosion and Sedimentation Controls.
   4. Section 32 93 43 – Tree Protection and Removal
   5. Storm Water Pollution Prevention Plan (SWPPP) and details.

1.2 ENVIRONMENTAL REQUIREMENTS
A. Construct temporary erosion control systems as shown on Construction Drawings or as directed by the
   Storm Water Pollution Prevention Plan (SWPPP) to protect adjacent properties and water resources
   from erosion and sedimentation.
B. Because sitework on this project will disturb less than 1 acre, coverage under the general permit to
   discharge stormwater is not required by the Texas Commission on Environmental Quality (TCEQ).
   Refer to the TCEQ website (www.tceq.state.tx.us) for complete permitting details.
C. Contractor shall conduct storm water management practices in accordance with TPDES permit and
   shall enforce action taken or imposed by Federal or State agencies, including cost of fines, construction
   delays, and remedial actions resulting from Contractor's failure to comply with provisions of TPDES
   permit.

1.3 PROJECT CONDITIONS
A. Conditions existing at time of inspection for bidding purposes will be maintained by Owner as
   reasonably practical.

PART 2 - PRODUCTS
Not Used

PART 3 - EXECUTION

3.1 PREPARATION
A. Identify existing plant life that is to remain and verify clearing limits are clearly tagged, identified, and
   marked in such manner as to ensure their protection throughout construction operations.

3.2 PROTECTION
A. Locate, identify, and protect existing utilities that are to remain.
B. Protect trees, plant growth, and features designated to remain as part of final landscaping. Erect
   high-visibility orange construction fencing beneath the dripline of any existing trees designated to remain;
   storage of materials and vehicle access beneath the dripline of trees to remain shall be prohibited.
   Where proposed excavation, pavements or structures shall occur within the dripline of any tree to remain,
   contractor shall prune roots with a rock saw along a line within 12" to 18" beyond the limits of the future
   excavation, paving or structure.
C. Conduct operations with minimum interference to public or private accesses and facilities. Maintain
   ingress and egress at all times and clean or sweep roadways daily as required by SWPPP or
governing authority. Dust control shall be provided with sprinkling systems or equipment provided by Contractor.

D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and re-placed, as necessary, in kind.

E. Provide traffic control as required, in accordance with the US Department of Transportation's "Manual on Uniform Traffic Control Devices" and applicable state highway department requirements.

3.3 EQUIPMENT
A. Material shall be transported to and from the project site using well-maintained and operating vehicles. Transporting vehicles operating on site shall stay on designated haul roads and shall not endanger improvements by rutting, overloading, or pumping.

3.4 CLEARING
A. Clear areas required for access to site and execution of work. When possible, clearing of the entire site at one time shall be avoided in favor of staging clearing operations as new construction sequence of operations dictates.

B. Unless otherwise indicated on Construction Drawings, remove trees, shrubs, grass, other vegetation, improvements, or obstructions interfering with installation of new construction. Removal includes digging out stumps and roots. Depressions caused by clearing and grubbing operations shall be filled to subgrade elevation to avoid ponding of water. Satisfactory fill material shall be placed in accordance with Section 31 20 00.

C. Remove grass, trees, plant life, stumps, and other construction debris from site to dump site that is suitable for handling such material according to state laws and regulations.

D. Cut heavy growths of grass from areas before stripping and topsoil removal and remove cuttings with remainder of cleared vegetative material.

END OF SECTION
SECTION 31 20 00  
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes:
1. Excavation, filling, and backfilling for structures and on-site pavement.
2. Trenching and backfilling for utilities.
3. Dewatering.
B. Related Sections
1. Section 31 25 00 – Erosion and Sedimentation Controls: Temporary and permanent erosion control.
2. Section 31 32 00 – Soil Stabilization
3. Section 31 37 00 – Riprap: Riprap stone for slope protection.
4. Section 32 90 00 – Planting: Topsoil and revegetation.

1.2 REFERENCES
A. American Society for Testing and Materials (ASTM)
1. ASTM D 422 – Standard Test Method For Particle Size Analysis of Soil
2. ASTM D 448 – Standard Classification for Sizes of Aggregate for Road and Bridge Construction
3. ASTM D 698 – Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft³ (600 kN·m/m³))
4. ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft³ (2,700 kN·m/m³))
5. ASTM D 2321 – Standard Practice for Underground Installation of Thermoplastic Pipe
6. ASTM D 2487 – Unified Soil Classification System
7. ASTM D 2940 – Graded Aggregate Material for Bases or Subbases for Highways or Airports
8. ASTM D 4318 – Liquid Limit, Plastic Limit, and Plasticity Index of Soils
9. ASTM D 6938 – In-Place Density and Water Content or Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
B. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO T88 – Particle Size Analysis of Soils
2. AASHTO T180 – Standard Method of Test for Moisture-Density Relationships of Soils
C. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or on the Construction Drawings) to various item (or section) numbers from State DOT specifications are for purposes of additional information only; where conflicts may exist, the project specifications herein shall supersede the referenced State DOT specs. General requirements of the State DOT specifications as related to bid award, contract execution, scope of work, measurement and payment shall not be binding on this project unless otherwise specified in writing.
D. National Fire Protection Association (NFPA)
1. NFPA 70 – National Electrical Code

1.3 QUALITY ASSURANCE
A. An Independent Testing Laboratory will be retained to perform construction testing on site.
1. The Independent Testing Laboratory shall prepare test reports that indicate test location, elevation data, and test results. Owner, Engineer and Contractor shall be provided with copies of reports within 96 hours of time that test was performed. In event that test performed fails to meet Specifications, the independent testing laboratory shall notify Owner and Contractor immediately.
2. Costs related to retesting due to failures shall be paid for by the Contractor at no additional expense to Owner. Contractor shall provide free access to site for testing activities.
3. Quality assurance testing will be conducted in accordance with Paragraph “Field Testing” in Part 3 hereinafter.

1.4 DEFINITIONS
A. Satisfactory Soils: ASTM D 2487 soil classification groups GW, GP, GM, SM, SW, SP, SC and CL, or a combination of these group symbols, subject to the limitations and requirements for use set forth in the geotechnical report (Job No. G 4836-17 by ETTL), and being free of rock or gravel larger than allowed for fill or backfill material as specified hereinafter or as shown on the drawings. Satisfactory soil shall contain no debris, waste, frozen materials, vegetation, and other deleterious matter.
B. Unsatisfactory Materials: Materials which do not comply with the requirements for satisfactory materials are unsatisfactory including materials classified in ASTM D 2487 soil classification groups GC, ML, MH, CH, OL, OH, and PT, or a combination of these group symbols.
   1. Unsatisfactory materials also include man-made fills; trash; refuse; backfills from previous construction; and material classified as satisfactory which contains root and other organic matter or frozen material. The Owner shall be notified of any contaminated materials.
   2. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
C. Building Select Fill: All fill placed beneath buildings shall consist of materials complying with “Satisfactory Soils” listed above, and in accordance with the above-referenced geotechnical report recommendations. Building Select Fill shall be free of organics or other deleterious materials, homogeneous mixture, have a maximum particle size of 3 inches, liquid limit of 40 or less, a percent passing the No. 200 sieve of 60% or less and a plasticity index less than 18. Refer to the geotechnical report.
D. Pavement Select Fill: The top 18” of pavement subgrade fill shall consist of materials complying with “Satisfactory Soils” listed above, and in accordance with the above-referenced geotechnical report recommendations. Select fill shall be free of organics or other deleterious materials, homogeneous mixture, have a maximum particle size of 3 inches, liquid limit of 40 or less, a percent passing the No. 200 sieve of 60% or less and a plasticity index less than 18. Refer to the geotechnical report.

1.5 SUBMITTALS
A. Submit 30-pound sample of each type of off-site fill material that is to be used at the site in airtight containers to the Independent Testing Laboratory or submit gradation and certification of aggregate material that is to be used at the site to the independent testing laboratory for review.
B. Submit certification that all material obtained from off-site sources complies with specification requirements.
C. Submit name of each material supplier and specific type and source of each material. Change in source throughout project requires approval of Owner.
D. If fabrics or geogrids are to be used, design shall be submitted for approval to Owner.
E. Submit Dewatering Plans upon request by Owner.
F. Shop drawings or details pertaining to excavating and filling are not required unless otherwise shown on the Drawings or if contrary procedures to Construction Documents are proposed.
G. Shop drawings or details pertaining to site utilities are not required unless required by regulatory authorities or unless uses of materials, methods, equipment, or procedures that are contrary to The Drawings or Specifications are proposed. Do not perform work until Owner has accepted required shop drawings.
H. Contact utility companies and determine if additional easements will be required to complete project. Provide written confirmation of the status of all easements to Owner at time of Preconstruction Conference.

PART 2 - PRODUCTS
A. Fill and Backfill. Satisfactory soil materials excavated from the site (see 1.4, above). Lean clay (CL) and fat clay (CH) soils shall not be utilized as backfill for walls above or below grade, including retaining and stem walls.
B. Imported Fill Material: Satisfactory borrow material provided from offsite borrow areas when sufficient satisfactory soil materials are not available from required excavations.
C. Trench Backfill: ASTM D 2321 unless otherwise specified or shown on the drawings.
D. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; 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: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch sieve and not more than 8 percent passing a No. 200 sieve. Refer to Section 32 11 00 for base requirements for all paving sections.
F. Bedding: Aggregate Type as indicated on the plans or naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch sieve and not more than 8 percent passing a No. 200 sieve.
G. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch sieve and 0 to 5 percent passing a No. 8 sieve.
H. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch sieve and 0 to 5 percent passing a No. 4 sieve.
I. Topsoil: Topsoil shall consist of stripping material excavated from the site. Topsoil shall consist of organic surficial soil found in depth of not more than 6-inches. Topsoil shall be as further defined in Section 32 90 00.
J. Filter and drainage fabrics: As specified in Section 31 25 00 unless otherwise shown on Construction Drawings.
K. Steel Casing Pipe: Comply with AWWA C200 minimum grade B, size and wall thickness as indicated on the Construction Drawings.
L. Trench Utility Locator Tape: Heavy duty 6" wide underground warning tape. Tape shall be made from polyethylene material, 3.5 mils thick, with a minimum tensile strength of 1,750 psi. Place the tape at one-half the minimum depth of cover for the utility line or a maximum of 3 feet, whichever is the less, but never above the top of subgrade. Color of tape shall be determined by as follows:
   1. Natural Gas or Propane - Yellow
   2. Electric - Red
   3. Telephone – Orange
   4. Water – Blue
   5. Sanitary Sewer – Green

2.2 EQUIPMENT
A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

2.3 SOURCE QUALITY CONTROL
A. Laboratory testing of materials proposed for use in the project shall be by the Independent Testing Laboratory at no cost to Contractor, unless otherwise specified within the Contract Documents. The Contractor shall provide samples of material obtained off-site.
B. In areas to receive pavement, California Bearing Ratio (CBR) tests shall be performed for each type of material that is imported from off-site. CBR value shall be equal to or above pavement design subgrade CBR value indicated in the Geotechnical Report.
C. Following tests shall be performed on each type of on-site or imported soil material used as compacted fill:
   1. Moisture and Density Relationship: ASTM D 698 or ASTM D 1557.
   3. Plasticity Index: ASTM D 4318

PART 3 - EXECUTION

3.1 PREPARATION
A. Identify required lines, levels, contours, datum, elevations, and grades necessary for construction as shown on the drawings.
B. Notify utility companies to remove or relocate public utilities that are in conflict with proposed improvements.
C. Protect plant life, lawns, fences, existing structures, sidewalks, paving, and curbs, unless otherwise noted on the drawings from excavating equipment and vehicular traffic.
D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.
E. Remove from site, material encountered in grading operations that, in opinion of Owner or the Independent Testing Laboratory, is unsuitable or undesirable for backfilling, subgrade, or foundation purposes. Dispose of unsuitable materials in manner satisfactory to Owner. Backfill areas with layers of suitable material and compact as specified herein.
F. Prior to placing fill in low areas, such as previously existing creeks, ponds, or lakes, perform following procedures:
   1. Drain water out by gravity with ditch having flow line lower than lowest elevation in low area. If drainage cannot be performed by gravity ditch, use adequate pump to obtain the same results.
   2. After drainage of low area is complete, remove muck, mud, debris, and other unsuitable material by using acceptable equipment and methods that will keep natural soils underlying low area dry and undisturbed.
   3. All muck, mud, and other materials removed from low areas shall be dried on-site by spreading in thin layers for observation by the Independent Testing Laboratory. Material shall be inspected and, if found to be suitable for use as fill material, shall be incorporated into lowest elevation of site filling operation, but not under building subgrade or within 10'-0" of perimeter of building subgrade or paving subgrade. If, after observation by the Independent Testing Laboratory, material is found to be unsuitable, unsuitable material shall be removed from site or disposed of on-site at locations determined by the Engineer and the Owner’s Representative.
G. Locate and identify existing utilities that are to remain and protect from damage.
H. Maintain in operating condition existing utilities, previously installed utilities, and drainage systems encountered in utility installation. Repair surface or subsurface improvements shown on The Drawings.
I. Verify location, size, elevation, and other pertinent data required for making connections to existing utilities and drainage systems as indicated on the Construction Drawings.
J. Over-excavate and properly prepare areas of subgrade that are not capable of supporting proposed systems. Stabilize these areas by using acceptable geotextile fabrics, geogrids and/or aggregate material placed and compacted properly. In accordance with the geotechnical report, all building foundations shall be supported by a minimum of eight (8") of scarified select fill, adjust the moisture content to, and maintain it within a range of optimum -3 to optimum +3 percent and recompact to a minimum density of 95% of the maximum density defined by ASTM D 698 (Standard Proctor).

3.2 DEWATERING
A. General:
   1. Design and provide dewatering system as required for excavations using accepted and professional methods consistent with current industry practice to eliminate water entering the excavation under hydrostatic head from the bottom or sides. Provide dewatering system of sufficient size and capacity to prevent ground and surface water flow into the excavation and to allow Work to be installed in a dry condition.
   2. Install wells or wellpoints, if required, with suitable screens and filters so that continuous pumping of fines does not occur. Arrange discharge to facilitate collection of samples by the Owner.
   3. Control grading around excavations to prevent surface water from flowing into excavation areas.
B. Design:
   1. Designate and obtain the services of a qualified dewatering specialist to provide dewatering plan as may be necessary to complete the Work.
   2. Contractor shall be responsible for the accuracy of the drawings, design data, and operational records required.
   3. Contractor shall be responsible for the design, installation, operation, maintenance, and any failure of any component of the system.
C. Maintaining Excavation in Dewatering Condition:
   1. Dewatering shall be a continuous operation. Interruptions due to power outages or any other reason will not be permitted.
   2. Continuously maintain excavation in a dry condition with positive dewatering methods during preparation of subgrade, installation of pipe, and construction of structures until the critical period of construction or backfill is completed to prevent damage of subgrade support, piping, structure, side slopes, or adjacent facilities from flotation or other hydrostatic pressure imbalance.

D. System Removal: Upon completion of the work, remove dewatering equipment from the site, including related temporary electrical service.

E. Wells shall be removed or cut off a minimum of 3 feet below final ground surface, capped, and abandoned in accordance with regulations by agencies having jurisdiction.

3.3 TOPSOIL EXCAVATION
A. Cut heavy growths of grass from areas before stripping and remove cuttings with remainder of cleared vegetative material.
B. Strip topsoil to a depth of not less than 6 inches from areas that are to be filled, excavated, landscaped, or re-graded to such depth that it prevents intermingling with underlying subsoil or questionable material.
C. Stockpile topsoil in storage piles in areas shown on Construction Drawings or where directed by Owner. Construct storage piles to freely drain surface water. Cover storage piles as required to prevent windblown dust. Dispose of unsuitable topsoil as specified for waste material, unless otherwise specified by Owner. Remove excess topsoil from site unless specifically noted otherwise on Construction Drawings.

3.4 GENERAL EXCAVATION
A. Classification of Excavation: The Contractor shall assure himself by site investigation or other necessary means that he is familiar with the type, quantity, quality, and character of excavation work to be performed. Excavation shall be considered unclassified excavation, except as indicated in the Contract Documents.
B. When performing grading operations during periods of wet weather, provide adequate dewatering, drainage and ground water management to control moisture of soils. During the geotechnical field investigations, groundwater seepage was encountered in all borings with groundwater levels ranging from 11 to 15 feet during dry flight auger drilling, and from 9 to 11 feet upon completion of drilling, as noted in the geotechnical report. It is possible that groundwater elevations may fluctuate and/or become perched at shallower depths and may be encountered during excavation and trenching. Surficial soils on this site are expected to be relatively sensitive to disturbances caused by construction traffic when wet. Pumping subgrades are possible on this site. The contractor shall, during periods of wet weather, create working platforms as necessary by means of one or more of the following: chemical stabilization (hydrated lime, flyash, cement, cement kiln dust, or combination thereof), dewatering through sumps and pumps, construction of temporary bleeder ditches, overexcavation/replacement and/or drying of wet soils.
C. Shore, brace, and drain excavations as necessary to maintain excavation as safe, secure, and free of water at all times.
D. Excavate building areas to line and grade as shown on the Drawings being careful not to over excavate beyond elevations needed for building subgrades. As stated previously in 3.1(j) herein, over-excavation of sufficient depth to allow placement of eight (8") of select fill beneath all building slabs shall be required.
E. Place suitable excavated material into project fill areas. All building slabs shall be constructed on eight (8") of select fill, as stated in the geotechnical report.
F. Unsuitable excavated material shall be disposed of in manner and location that is acceptable to Owner and local governing agencies. Disposal of excess soils on-site shall be only at locations determined by the Engineer and the Owner’s Representative, placed in uniform, density-controlled lifts not exceeding 12-inches, and re-vegetated in accordance with Section 32 90 00.
G. Perform excavation using capable, well-maintained equipment and methods acceptable to Owner and local governing agencies.
3.5 ROCK EXCAVATION (NOT USED)

3.6 TRENCHING EXCAVATION FOR UTILITIES

A. Contact local utility companies before excavation begins. Dig trench at proper width and depth for laying pipe, conduit, or cable. Cut trench banks vertical, if possible, and remove stones from bottom of trench as necessary to avoid point-bearing. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide suitable base for continuous and uniform bedding. Replace overexcavation with suitable and dispose of unsuitable material.

B. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.

C. Perform trench excavation as indicated on the Drawings for specified depths. During excavation, stockpile materials suitable for backfilling in orderly manner far enough from bank of trench to avoid overloading, slides, or cave-ins.

D. Remove excavated materials not required or not suitable for backfill or embankments and waste off-site or at on-site locations approved by the Owner. Dispose of structures discovered during excavation as specified in Section 02 41 13.

E. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches and other excavations as specified.

F. Open cut excavation with trenching machine or backhoe. Where machines other than ladder or wheel-type trenching machines are used, do not use clods for backfill.

G. Accurately grade trench bottom to provide uniform bearing and support for each section of pipe on bedding material at every point along entire length except where necessary to excavate for bell holes, proper sealing of pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make joint connection properly.

H. Trench width below top of pipe shall not be less than 12 inches nor more than 18 inches wider than outside surface of pipe or conduit that is to be installed to designated elevations and grades. Other trench width for pipe, conduit, or cable shall be least practical width that will allow for proper compaction of trench backfill.

I. Trench depth requirements measured from finished grade or paved surface shall meet the following requirements or applicable codes and ordinances, whichever is more stringent:
   1. Water Mains: 60 inches to top of pipe barrel or 6 inches below frost line, established by local building officials, whichever is deeper.
   2. Sanitary Sewer: Elevations and grades as indicated on the drawings and as specified in Section 33 31 00.
   3. Storm Sewer: Elevations and grades as indicated on the Drawings.
   4. Electrical Conduits: 24 inches minimum to top of conduit or as required by NEC 300-5, NEC 710-36 codes, or local utility company requirements, whichever is deeper.
   5. TV Conduits: 18 inches minimum to top of conduit or as required by local utility company, whichever is deeper.
   6. Telephone Conduits: 18 inches minimum to top of conduit, or as required by local utility company, whichever is deeper.
   7. Gas Mains and Service: 30 inches minimum to top of pipe, or as required by local utility company, whichever is deeper.

3.7 SUBGRADE PREPARATION

A. Scarification and Compaction: Areas exposed by excavation or stripping and on which subgrade preparations are to be performed shall be scarified to minimum depth of eight (8) inches and compacted as specified hereinafter.

B. Proofrolling: Subgrades shall be proofrolled to detect areas of insufficient compaction. After stripping, undercutting, and excavation (in accordance with the Grading Plan and geotechnical report), proofrolling in all pavement areas shall be accomplished by making minimum of 2 complete passes with
a pneumatic-tired vehicle (e.g., fully-loaded tandem-axle dump truck) with a weight of 20 to 25 tons, in each of 2 perpendicular directions while under the supervision and direction of the Independent Testing Laboratory or geotechnical engineer. Proofrolling in all pavement areas shall be accomplished in accordance with TxDOT Item 216. Document and explain proofrolling inspection procedures and results in the laboratory inspection report. Areas of failure shall be excavated and recompacted as specified herein. Continual failure areas shall be stabilized in accordance with Section 31 32 00 at no additional cost to Owner.

C. After stripping, excavating (where required) and proof-rolling, but prior to placing fill in building areas, exposed soils shall be scarified to a depth of eight (8) inches, processed to a moisture content between three percent below (-3%) and three percent above (+3%) Standard Proctor optimum, then recompacted to a dry density of at least 95 percent of the Standard Proctor maximum dry density. In pavement areas, after proofrolling, the exposed soils shall be scarified and processed to a moisture content between two percent below (-2%) and three percent above (+2%) Standard Proctor optimum, then recompacted to a dry density of at least 95 percent of the Standard Proctor maximum dry density. In addition to density testing, all footing locations shall be hand-probed by the Independent Testing Laboratory prior to placement of steel reinforcing.

D. In all pavement areas, the upper eighteen (18") of subgrade shall consist of one of the following: (i) a liquid limit of 40 or less, less than 40% passing #200 sieve, and (PI) of 18 or less, or (ii) select fill as defined herein. Any areas with unsuitable subgrade soils (PI≥18), overexcavate the clays to a minimum depth of eighteen (18) inches below pavement subgrade prior to proofrolling. Proceed with scarifications and recompaction only after subgrade passes proofroll test.

3.8 FILLING

A. Fill areas to contours and elevations shown on the Drawings with unfrozen materials.

B. On slopes exceeding 15%, cut minimum 5-feet wide benches into existing subgrade prior to placing fill.

C. Place fills in continuous lifts specified herein in areas that have been prepared according to 3.7 (above).

D. Fill within proposed building subgrade and paving subgrade shall not contain rock or stone greater than 6 inches in any dimension.

E. Unless otherwise specified for rock fill, rock or stone less than 6-inches in largest dimension may be used in fill below structures, paving, and graded areas, up to 24 inches below surface of proposed subgrade (or finish grade of graded areas) when mixed with suitable material. Rock or stone less than 2 inches in largest dimension may be used in fill within the upper 24 inches of proposed subgrade or finish grade of graded areas when mixed with suitable material.

F. Fill materials used in preparation of subgrade shall be placed in lifts or layers not to exceed 8 inches loose measure and compacted as specified hereinafter. Where differing depths of fill soils are required beneath structures, they shall be transitioned at 10:1 (horizontal to vertical) or flatter slopes.

G. In all pavement areas requiring fill, the upper 24 inches of subgrade shall consist of pavement select fill as defined herein.

H. Material imported from off-site shall have CBR value equal to or above pavement design subgrade CBR value indicated in the Geotechnical Report.

I. Building area subgrade pad shall be that portion of site directly beneath and 5 feet beyond building and appurtenances. “Appurtenances” shall include all truck docks, canopies, exit porches and/or sidewalks adjacent to or within 5 feet of the building foundation. All requirements herein for building foundation subgrade preparation shall be constructed to a minimum distance of 5 feet beyond the outermost limits of said appurtenances.

J. Unless specifically stated otherwise on the Drawings, the following table stipulates maximum allowable values (or range of values) for plasticity index (PI) and liquid limit (LL) of suitable materials to be used as fill in specified areas:

<table>
<thead>
<tr>
<th>Location</th>
<th>PI</th>
<th>LL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Building area</td>
<td>less than 18</td>
<td>40</td>
</tr>
<tr>
<td>Paving area (upper eight inches)</td>
<td>less than 18</td>
<td>40</td>
</tr>
</tbody>
</table>
3.9 PIPE BEDDING
A. Excavate trenches for pipe or conduit to 4 inches below bottom of pipe and to the width as specified herein. Place 4 inches of bedding material, compact in bottom of trench, and shape to conform to lower portion of pipe barrel.
B. Place geotextile fabric when specified on the Drawings and in accordance with Section 31 32 00.

3.10 TRENCH BACKFILLING
A. Materials used for trench backfill shall comply with requirements as specified herein.
B. Backfill and compact in accordance with fill and compaction requirements in accordance with ASTM D 2321 unless otherwise shown on the drawings.
C. Do not backfill trenches until required tests are performed and utility systems comply with and are accepted by applicable governing authorities.
D. Backfill trenches to contours and elevations shown on the Drawings.
E. Do not backfill over porous, wet, frozen, or spongy subgrade surfaces.

3.11 COMPACTION
A. Compact as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>% of Max. Lab Density (ASTM D 698)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fill below structures (thickness &lt; 6 ft)</td>
<td>95</td>
</tr>
<tr>
<td>Fill below structures (thickness &gt; 6 ft)</td>
<td>100</td>
</tr>
<tr>
<td>Subgrade &amp; Fill in Pavement Areas</td>
<td>95</td>
</tr>
<tr>
<td>Utility Trench Backfill</td>
<td>95</td>
</tr>
<tr>
<td>Subgrade &amp; Fill in all other areas</td>
<td>92</td>
</tr>
</tbody>
</table>

Note: If any portion of the fill beneath the structure exceeds four feet (4') then the entire select fill pad shall be compacted to the 98% density level.
B. Maintain moisture content of not less than three percent below (-3%) optimum and not more than three percent above (+3%) optimum moisture content of fill materials to attain required compaction density.
C. Exercise proper caution when compacting immediately over top of pipes or conduits. Water jetting or flooding is not permitted as method of compaction.
D. Corrective Measures for Non-Complying Compaction: Remove and recompact deficient areas until proper compaction is obtained. Continual failure areas shall be stabilized in accordance with Section 31 32 00 at no additional cost to Owner.

3.12 MAINTENANCE OF SUBGRADE
A. Verify finished subgrades to ensure proper elevation and conditions for construction above subgrade. Field density test results shall become void if construction of foundations or placement of pavement section materials is not commenced within 48 hours after testing, or if subgrade is exposed to precipitation.
B. Protect subgrade from excessive wheel loading during construction, including concrete trucks, dump trucks, and other construction equipment.
C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material with CBR equal to or better than that specified in the Geotechnical Report. Surface of subgrade after compaction shall be firm, uniform, smooth, stable, and true to grade and cross-section.
D. Construct temporary ditches and perform such grading as necessary to maintain positive drainage away from subgrade at all times.

3.13 BORROW AND SPOIL SITES
A. Comply with TPDES and local erosion control permitting requirements for any and all on-site and off-site, disturbed spoil and borrow areas. Upon completion of spoil or borrow operations, clean up spoil or
borrow areas in a neat and reasonable manner to the satisfaction of Owner or off-site property owner, if applicable.

3.14 FINISH GRADING
A. Check grading of building subgrades by string line from grade stakes (blue tops) set at not more than 50-foot centers. Allowable tolerance shall be plus or minus 0.10 feet from plan grade. Provide engineering and field staking as necessary for verification of lines, grades, and elevations.
B. Grade areas where finish grade elevations or contours are indicated on the Drawings, other than paved areas and buildings, including excavated areas, filled areas and landscaped areas. Graded areas shall be uniform and smooth, free from rock, debris, or irregular surface changes. Ground surfaces shall vary uniformly between indicated elevations. Grade finished ditches to allow for proper drainage without ponding and in manner that will minimize erosion potential. For topsoil, sodding, and seeding requirements refer to Section 32 90 00
C. Correct settled and eroded areas within 1 year after date of completion at no additional expense to Owner. Bring grades to proper elevation.

3.15 FIELD TESTING
A. Field density tests for in-place materials will be performed by the Independent Testing Laboratory (ITL) as follows:
   1. Building Subgrade Areas, Including 5'-0" Outside of Exterior Building Lines: In cut areas, not less than 1 compaction test for every 3,000 sq. ft. (minimum 4 tests per structure). In fill areas, same rate of testing for each 8-inch lift, with a minimum 4 tests per lift, measured loose.
   2. Pavement Subgrade Areas: In cut areas, not less than 1 compaction test for every 5,000 sq. ft. (minimum 4 tests per paving area). In fill areas, same rate of testing for each 8-inch lift, with a minimum 4 tests per lift per paving area, measured loose.
   3. Utility Trench Backfill: Intervals not exceeding 200-feet of trench for each 8-inch lift of compacted trench backfill (minimum 1 test each lift in each trench).
B. Corrective Measures For Non-Complying Compaction: Remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner. Adjust moisture content as necessary to conform to the requirements of this section.
C. Field testing, frequency, and methods may vary as determined by and between the Owner and the ITL.

END OF SECTION
SECTION 31 25 00
EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Installation of temporary and permanent erosion and sedimentation control systems.
   2. Installation of temporary and permanent slope protection systems.
B. Related Sections
   1. Section 31 10 00 – Site Clearing
   2. Section 31 20 00 – Earthwork
   3. Section 31 37 00 – Riprap
   4. Section 32 90 00 – Planting
   5. Section 33 40 00 – Storm Drainage Utilities
   6. Storm Water Pollution Prevention Plan (SWPPP)
   7. Construction Drawings

1.2 ENVIRONMENTAL REQUIREMENTS
A. Protect adjacent properties, any identified endangered or threatened species or critical habitat, any identified cultural or historic resources, and receiving water resources from erosion and sediment damage until final stabilization.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Quick growing grasses such as wheat, rye, or oats in accordance with Landscape Planting Specifications, when applicable, or as shown on the Construction Drawings.
B. Silt Fencing and/or Straw Roll Wattles for sedimentation control as specified on the Construction Drawings.
C. Turf Reinforcement Mats (TRMs), Erosion Control Blankets (ECBs), excelsior blankets and other revegetation mats as shown on the Construction Drawings.
D. Temporary mulches such as loose straw, netting, wood cellulose, or agricultural silage.
E. Rip-Rap as specified in Section 31 37 00 or as shown on Construction Drawings.
F. Temporary and permanent outfall structures as specified on the Construction Drawings.

PART 3 - EXECUTION

3.1 PREPARATION
A. Review the Construction Drawings and Storm Water Pollution Prevention Plan (SWPPP)
B. Because sitework on this project will disturb less than 1 acre, coverage under the general permit to discharge stormwater is not required by the Texas Commission on Environmental Quality (TCEQ). Refer to the TCEQ website (www.tceq.state.tx.us) for complete permitting details.
C. Revise SWPPP, if necessary, to address potential pollution from site identified after issuance of the SWPPP at no additional cost to the owner.
D. Conduct pre-construction stormwater meeting with Engineer upon request of Owner.

3.2 EROSION AND SEDIMENTATION CONTROL AND SLOPE PROTECTION IMPLEMENTATION
A. Place erosion control systems in accordance with the Construction Drawings and SWPPP or as may be dictated by site conditions in order to maintain the intent of the specifications and permits.
B. Deficiencies or changes on the Construction Drawings or SWPPP shall be corrected or implemented as site conditions change. Changes during construction shall be noted in the SWPPP and marked on the Construction Drawings (SWPPP Site Map).
C. Owner has authority to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and to direct Contractor to provide immediate permanent or temporary pollution control measures.

D. Maintain temporary erosion and sedimentation control systems as dictated by site conditions, indicated in the construction documents, or as directed by governing authorities or Owner to control sediment until final stabilization. Contractor shall respond to maintenance or additional work ordered by Owner or governing authorities immediately, but in no case, within not more than 7 days if required at no additional cost to the Owner.

E. Contractor shall incorporate permanent erosion control features, paving, permanent slope stabilization, and vegetation into project at earliest practical time to minimize need for temporary controls.

F. Permanently seed and mulch cut slopes as excavation proceeds to extent considered desirable and practical.

G. Slopes that erode easily or that will not be graded for a period of 14 days or more shall be temporarily seeded as work progresses with wheat, rye, or oats application in accordance with Landscape Planting specifications (Section 32 90 00), unless otherwise specified in the Contract Documents. In the event it is not practical to seed areas, slopes must be stabilized with geotextile fabric or other means to reduce the erosive potential of the area.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Excavation, treatment, and backfilling of subgrade for lime, cement, fly ash, or bridge lift stabilization.
   2. Geotextile Fabric and/or Geogrid for stabilization of subgrade.
B. Related Sections
   1. Section 31 20 00 – Earthwork

1.2 REFERENCES
A. American Society for Testing Materials (ASTM)
   1. ASTM C 150 – Portland Cement
   2. ASTM C 618 – Fly Ash and Raw or Calcined Natural Pozzolan for use as a Mineral Ad-mixture in Portland Cement Concrete
   3. ASTM C 977 – Quicklime and Hydrated Lime for Soil Stabilization
   4. ASTM D 421 – Standard Practice for Dry Preparation of Soil Samples for Particle-Size Analysis and Soil Constants
   5. ASTM D 698 – Laboratory Compaction Characteristics of Soil Using Standard Effort
   6. ASTM D 1633 – Compressive Strength of Molded Soil-Cement Cylinders
B. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M216 – Lime for Soil Stabilization
   2. AASHTO M288 – Geotextile Specification for Highway Applications
C. National Lime Association (NLA)
D. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or on the Construction Drawings) to various item (or section) numbers from State DOT specifications are for purposes of additional information only; where conflicts may exist, the project specifications herein shall supersede the referenced State DOT specs. General requirements of the State DOT specifications as related to bid award, contract execution, scope of work, measurement and payment shall not be binding on this project unless otherwise specified in writing.

1.3 ENVIRONMENTAL REQUIREMENTS
A. Do not install mixed materials in wind in excess of 10 mph or when temperature is below 40 degrees Fahrenheit.

1.4 SUBMITTALS
A. Submit 30-pound sample of each material to be used at the site in airtight containers to the Independent Testing Laboratory or submit gradation and certification of material that is to be used to the Independent Testing Laboratory for review.
B. Submit name of each materials supplier and specific type and source of each material. Obtain approval of Owner prior to change in source.
C. Submit mix design and materials mix ratio to Independent Testing Laboratory that will achieve specified requirements as indicated in the documents (or as specified by state and local agencies for soil stabilization if not stated in documents).
D. If geogrids or geotextiles are to be used, design shall be submitted to Owner for approval.

1.5 QUALITY ASSURANCE
A. Perform work in accordance with state and local standards in conjunction with requirements specified herein.
PART 2 - PRODUCTS

2.1 MATERIALS

A. Soil Treatment Materials:
   1. Hydrated Lime: ASTM C 977 or AASHTO M216
   2. Portland Cement: ASTM C 150, Type I
   3. Fly Ash: ASTM C 618

B. Aggregate
   1. Coarse Aggregate: Crushed carbonate, crushed gravel, crushed air-cooled slag, granulated slag, a mixture of crushed and granulated slag, or other types of suitable material meeting the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 inches</td>
<td>100</td>
</tr>
<tr>
<td>1 inch</td>
<td>70-100</td>
</tr>
<tr>
<td>3/4 inch</td>
<td>50-90</td>
</tr>
<tr>
<td>No. 4</td>
<td>30-60</td>
</tr>
<tr>
<td>No. 30</td>
<td>7-30</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5</td>
</tr>
</tbody>
</table>

   2. Fine Aggregate: Sand – Natural river or bank sand; washed; free of silt, clay, loam, friable or soluble materials, and organic matter meeting the following gradation requirements:

<table>
<thead>
<tr>
<th>Sieve Size</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. 4</td>
<td>90-100</td>
</tr>
<tr>
<td>No. 50</td>
<td>7-40</td>
</tr>
<tr>
<td>No. 200</td>
<td>0-5</td>
</tr>
</tbody>
</table>

C. Subsoil: Existing to be reused.
D. Bridge Lift Material: Surge stone, granular fill, or shot rock fill.

2.2 ACCESSORIES

A. Curing Seal: Asphalt Emulsion Primer
B. Geotextile Fabric for Stabilization: Provide one of the following:
   1. Mirafi 500X or 600X, TenCate Geosynthetics
   2. Basetex, Tensar, Inc.
   3. Propex 250ST (woven) or Geotex 801 (non-woven), Hancor/Propex
C. Geogrid for Stabilization: Provide one of the following:
   1. Tensar BX 1100
   2. Tensar BX 1200

2.3 EQUIPMENT

A. Perform operations using suitable, well maintained equipment capable of excavating subsoil, mixing and placing materials, wetting, consolidating, and compacting of material.

PART 3 - EXECUTION

3.1 PREPARATION

A. Obtain approval from the Independent Testing Laboratory of mix design before proceeding with placement.
B. Start stabilization only when weather and soil conditions are favorable for successful application of proposed material.
C. Proofroll subgrade to identify areas in need of stabilization in accordance with Section 31 20 00.

3.2 EXCAVATION
A. Excavate subsoil to depth sufficient to accommodate soil stabilization.
B. Remove lumped subsoil, boulders, and rock that interfere with achieving uniform subsoil conditions.
C. Do not excavate within normal 45 degree bearing splay of any foundation.
D. Notify Owner’s representative of unexpected subsurface conditions. Discontinue affected work in area until notified to resume work.
E. Correct areas over-excavated in accordance with Section 31 20 00.
F. Remove excess excavated material from site.

3.3 GEOTEXTILE FABRIC AND/OR GEOGRID
A. Place geotextile fabric and/or geogrid over subsoil surface, lap edges and ends in accordance with manufacturer’s recommendations in those areas that are shown on Construction Drawings or in those areas that need additional stabilization prior to placement of base course. Bridge lift sections may require the use of geotextile fabric and/or geogrid for stabilization prior to placement of fill.
B. Place geotextile fabric and/or geogrid in accordance with manufacturer’s recommendations.

3.4 SOIL TREATMENT AND BACKFILLING
A. Lime Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared clayey subgrades (those with PI greater than 20) with hydrated lime in accordance with TxDOT specifications, Item 260. In addition to gradation requirements therein, the lime-stabilized clay shall have minimum 85 percent, on a dry weight basis, of the material passing a ¾-inch sieve, with moisture content at or above optimum. The lime-stabilized clay shall have a plasticity index of 15 or less based on dry sample method per ASTM D 421. A minimum five percent (5%) of lime by dry weight of soil shall be used for lean clays and minimum eight percent (8%) of lime by dry weight for fat clays. Lime-stabilized clay fill shall be placed in maximum 8-inch lifts compacted to minimum 95 percent of maximum dry density per ASTM D 698, at moisture content not less than optimum nor greater than 4 percent above optimum.
B. Cement Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with Portland cement in accordance with TxDOT specifications, Item 275. A minimum of six percent (6%) cement, by dry weight of soil, shall be used for silty sands, clayey sands and silty-clayey sands. Compact the cement-stabilized subgrade to minimum 95 percent of the maximum dry unit weight per ASTM D 698 at a moisture content within 2 percent of optimum.
C. Lime-Fly Ash Stabilized Subgrade: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade with lime-fly ash in accordance with TxDOT specifications, Item 265. A commercial lime-fly ash blend with a 70-30 mixture (lime to fly ash) shall be used for lean clays, sandy clays, clayey sands, silty-clayey sands and silty sands.
D. Bridge Lifts: Where indicated on Construction Drawings or as required after continual failure, treat prepared subgrade by application of a bridge lift. Bridging over existing soils shall be acceptable only when approved in writing by the Owner. Place geotextile fabric or geogrid over existing soils to be bridged. The geotextile fabric or geogrid selected shall be appropriate for the bridge lift material being placed. Place bridge lift over geotextile fabric or geogrid. Surge stone and shot rock will be approved by the Owner’s representative on a submittal basis. The Owner and the Owner’s representative shall have sole discretion as to the acceptability of all submittals.
E. Backfill and compaction of treated subsoil shall be in accordance with Section 31 20 00.
F. Maintain optimum moisture of mixed materials to attain required stabilization and compaction.
G. Finish subgrade surface in accordance with Section 31 20 00.
H. Remove surplus mix materials from site.

3.5 CURING
A. Immediately following compaction of mix, seal top surface with curing seal.
B. Do not permit traffic for 72 hours after sealing top surface.

3.6 FIELD QUALITY CONTROL
A. Unconfined compression tests on lime, fly ash, or cement treated mixture shall be conducted in accordance with ASTM D 1633. Three tests shall be conducted for each mix design tested. Samples shall be cured at a constant moisture content and temperature for 28 days. Scratch portion of the test shall be omitted.

B. Field Density: Field in-place density shall be determined as specified in Section 31 20 00. At least one field density test shall be performed for each 1000 square feet (or fraction thereof) of each layer of stabilized subgrade or subbase material.

C. If tests indicate work does not meet specified requirements, remove work, replace and retest.

END OF SECTION
SECTION 32 11 00
BASE COURSES

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Aggregate base for asphaltic concrete and Portland cement concrete paving, including hot-mix asphalt base.
B. Related Sections
   1. Section 31 20 00 – Earthwork: Excavation, Backfill, and Compaction for pavement subgrade.

1.2 REFERENCES
A. Asphalt Institute
B. American Society for Testing and Materials (ASTM)
   1. ASTM D 1557 – Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft² (2,700 Kn/m²))
   2. ASTM D 2041 – Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
   3. ASTM D 6938 – In-Place Density and Water Content or Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
C. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or on the Construction Drawings) to various item (or section) numbers from State DOT specifications are for purposes of additional information only; where conflicts may exist, the project specifications herein shall supersede the referenced State DOT specs. General requirements of the State DOT specifications as related to bid award, contract execution, scope of work, measurement and payment shall not be binding on this project unless otherwise specified in writing.

1.3 QUALITY ASSURANCE
A. An Independent Testing Laboratory will be retained to perform construction testing of in-place base course for compliance with requirements for thickness, compaction, density, and tolerances. Paving base course tolerances shall be verified by rod and level readings on not more than 50-foot centers to be not more than 0.05-feet above design elevation which will allow for paving thickness as shown on Construction Drawings. Contractor shall provide instruments and suitable benchmark.

1.4 SUBMITTALS
A. Submit materials certificate to the independent testing laboratory that is signed by materials producer and Contractor, certifying that materials comply with, or exceed, requirements specified herein or on the Construction Drawings.
B. Submit certification of base course materials and placement as specified in Parts 2 and 3 hereinafter.

1.5 WEATHER LIMITATIONS
A. Do not place aggregate when base surface temperature is less than 40 degrees F, nor when air temperature is below 45 degrees F. Do not place aggregate when surface is wet or frozen. Do not place aggregate when weather conditions are unfavorable otherwise.

PART 2 - PRODUCTS

2.1 BASE COURSE MATERIAL
A. Base course shall be as shown on the drawings, or when not shown, shall be as specified herein.
B. Aggregate Base Course: Aggregate base course shall consist of a well graded, durable aggregate uniformly moistened and mechanically stabilized by compaction. Aggregate base material requirements from TxDOT Standard Specifications shall be used for aggregate base course for roads, streets, or similar use pavements, unless specifically indicated otherwise on the Construction Drawings. Flexible base course shall conform to TxDOT Item 247, Type A, Grade 2. Wet ball mill tests, in accordance with TxDOT Standard Specifications, shall be required.

C. Aggregate shall consist of clean, sound, durable particles of crushed stone, crushed gravel, angular sand, or other approved material. Aggregate shall be free of lumps of clay, organic matter, and other objectionable materials or coatings. The portion retained on the No. 4 sieve shall be known as coarse aggregate; that portion passing the No. 4 sieve shall be known as fine aggregate.
   1. Coarse aggregates shall be angular particles of uniform density.
   2. Fine aggregates shall be angular particles of uniform density. Fine aggregate shall consist of screenings, angular sand, crushed recycled concrete fines, or other finely divided mineral matter processed or naturally combined with the coarse aggregate.

D. Gradation: The gradation requirements as specified by the TxDOT Standard Specifications for flexible base courses shall apply to the completed base course. The aggregates shall have a maximum size of 2 inches and shall be continuously well graded within the specified limits.

E. Hot-mix Asphalt Bases: Asphalt Institute Type VI, VII, or VIII Mixes for Hot-mix Asphalt Bases. Hot-mix asphalt base shall be used only under asphaltic concrete surfaces when specifically permitted on the Construction Drawings. Hot mix asphalt base, when used, shall conform to TxDOT Item 340, Type B and shall comply with all applicable requirements of Section 32 12 16.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Contractor shall verify to the Owner in writing that the subgrade has been inspected, tested, and that gradients and elevations are correct, dry, and properly prepared in accordance with Section 31 20 00.

3.2 CONSTRUCTION
   A. Perform base course construction in accordance with the applicable State standard specifications or as shown or specified.
   B. Perform base course construction in a manner that will drain the surface properly and prevent runoff from adjacent areas from draining onto base course construction.
   C. Compact granular base material to not less than 95 percent of maximum dry density, as determined by ASTM D 1557 (Modified Proctor), unless otherwise indicated on the Drawings. Compact asphaltic base material to a minimum of 95 percent of the dry density of the laboratory-molded specimen or a minimum of 92 percent of the maximum theoretical dry density.
   D. Construct to thickness indicated on Construction Drawings.
      1. Granular Base: Apply in lifts or layers not exceeding 8-inches, measured loose.
      2. Sand/Shell Base: Apply in lifts or layers not exceeding 4-inches, measured loose.
      3. Hot-mix Sand Asphalt Bases: Apply in lifts or layers not exceeding 3-inches, measured loose.

3.3 FIELD QUALITY CONTROL
   A. Field testing specified below will be performed by the Independent Testing Laboratory at no cost to the Contractor.
   B. Field testing, frequency, and methods may vary as determined by and between the Owner and the Independent Testing Laboratory.
   C. Field density tests for in-place materials will be performed in accordance with the following:
      1. Nuclear Method: ASTM D 6938 (Method B-Direct Transmission)
      2. Base material thickness: One test for each 20,000 sq. ft. of in-place base material area.
      3. Base material compaction: One test in each lift for each 20,000 sq. ft. of in-place base material area.

   D. The Independent Testing Laboratory will prepare reports that indicate test location, elevation data, and test results. Owner and Contractor shall be provided with copies of the reports within 96 hours of
the time the test was performed. In the event that the test results show failure to meet any of the Specifications; Owner and Contractor will be notified immediately by the independent testing laboratory.

E. The Contractor shall certify in writing to the Owner that base course placement is in accordance with specification requirements prior to subsequent work thereon.

F. The Contractor shall pay for retesting due to failures at no additional expense to Owner. Contractor shall provide free access to the site for testing activities.

END OF SECTION
SECTION 32 12 16
ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes
1. Asphalitic concrete binder and surface course for on-site parking areas and drives.
2. Asphalitic concrete binder and surface course for public streets and roadways.

B. Related Sections
1. Section 31 20 00 – Earthwork: Excavation, backfill and compaction for pavement subgrade
2. Section 32 11 00 – Base Courses
3. Section 32 17 23 – Pavement Markings

1.2 REFERENCES
A. The Asphalt Institute (AI)
1. MS 2 - Mix Design Methods/ Asphalt Concrete/ Hot Mix Types

B. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and
   Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or
   on the Construction Drawings) to various item (or section) numbers from State DOT specifications are
   for purposes of additional information only; where conflicts may exist, the project specifications herein
   shall supersede the referenced State DOT specs. General requirements of the State DOT
   specifications as related to bid award, contract execution, scope of work, measurement and payment
   shall not be binding on this project unless otherwise specified in writing.

C. American Society of Testing and Materials (ASTM)
1. ASTM D 1188 – Bulk Specific Gravity and Density of Compacted Bituminous Mixtures Using
   Coated Samples.
3. ASTM D 2041 – Standard Test Method for Theoretical Maximum Specific Gravity and Density of
   Bituminous Paving Mixtures
4. ASTM D 2726 – Bulk Specific Gravity and Density of Non-Absorptive Compacted Bituminous
   Mixture.
5. ASTM D 2950 – Density of Bituminous Concrete In Place by the Nuclear Method
6. ASTM D 5444 – Mechanical Size Analysis of Extracted Aggregate.

D. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO M 17 – Mineral Filler for Bituminous Paving Mixtures.
2. AASHTO M 140 – Emulsified Asphalt
3. AASHTO M 208 – Cationic Emulsified Asphalt
4. AASHTO M 226 – Viscosity Graded Asphalt Cement
5. AASHTO T 209 – Maximum Specific Gravity of Bituminous Paving Mixtures
7. AASHTO TP 53 – Asphalt Content of Hot Mix Asphalt by the Ignition Method

1.3 QUALITY ASSURANCE
A. An Independent Testing Laboratory will be retained to perform construction testing of in-place
   asphalitic concrete courses for compliance with requirements for thickness, compaction, and surface
   smoothness.
B. Failing test results shall be faxed within 24 hours to Engineer and Owner.

1.4 SUBMITTALS
A. Within 30 days prior to asphalt construction, submit actual design mix to Engineer and to
   Independent Testing Laboratory for review and approval. Design mix submittal shall follow a format as indicated in
   Asphalt Institute Manual MS-2, and shall include type/name of mix, gradation analysis, grade of asphalt
   cement used, effective asphalt content in percent, Hamburg Wheel test results, Performance Grade (PG)
binder spec, and direct references to TxDOT specifications sections for each material. Design shall be 
for mixture listed in current edition of TxDOT specifications. Mix designs over 3 years old will not be 
accepted by Owner. Submit certification that mix design conforms to specification requirements.

B. Submit materials certificate to the Independent Testing Laboratory that is signed by materials 
producer and Contractor, certifying that materials and mix design conform to requirements specified 
herein.

C. Submit certification of asphalt placement as required hereinafter.

D. The Independent Testing Laboratory shall submit all certificates furnished with the Independent Testing 
Laboratory reports.

1.5 PROJECT CONDITIONS

A. Weather Limitations:
   1. Apply prime and tack coats when ambient or base surface temperature is above 40 F, and when 
temperature has been above 35 F for 12 hours immediately prior to application. Do not apply when 
base is wet, contains excess moisture, during rain, or when frozen.
   2. Construct asphaltic concrete paving when ambient temperature is above 40 F.

B. Maintain access for vehicular and pedestrian traffic as required for other construction activities.
   Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Aggregate: If specified aggregate is scarce, use locally available materials and gradations that meet 
TxDOT specifications and exhibit satisfactory records of previous installations.

B. Asphalt Cement: Comply with AASHTO M 226; Table 2 AC-10, AC-20, or AC-40, viscosity grade, 
depending on local mean annual air temperature in accordance with the following chart:

<table>
<thead>
<tr>
<th>Temperature Condition</th>
<th>Asphalt Grades</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold: Mean annual air temperature 45 F or lower</td>
<td>AC-10</td>
</tr>
<tr>
<td>Hot: Mean annual air temperature 75 F or higher</td>
<td>AC-40</td>
</tr>
<tr>
<td>Warm: Mean annual air temperature between 45 F and 75 F</td>
<td>85/100 pen.</td>
</tr>
</tbody>
</table>

C. Prime Coat: Medium curing cut-back asphalt or asphalt penetrating prime coat consisting of either 
MC-30 or AE-P, in accordance with TxDOT Items 300 and 310.

D. Tack Coat: Emulsified asphalt; AASHTO M 140 or AASHTO M 208; SS-1H or CSS-1H in 
accordance with TxDOT Item 300; diluted with 1 part water to 1 part emulsified asphalt.

E. Mineral Filler: Rock or slag dust, crusher fines, hydrated lime or cement, flyash or other inert 
material complying with AASHTO M 17 and TxDOT Item 340.

F. Asphalt-Aggregate Mixture: Unless otherwise noted on the Drawings, design mix shall have 
minimum stability based in accordance with TxDOT Standard Specifications. The design mix shall be 
within sieve analysis and bitumen ranges specified for each of the following Types (surface or base 
course) in accordance with TxDOT Standard Specifications, unless approved otherwise by Owner prior 
to placement:
   1. Surface Course: TxDOT Item 340, Type C or D
   2. Base Course: TxDOT Item 247, Type B

2.2 EQUIPMENT

A. Equipment necessary for the paving of asphaltic concrete shall be on the project prior to beginning 
paving operations.
B. Maintain equipment in satisfactory operating condition and correct breakdowns in manner that will not delay or be detrimental to the schedule of paving operations.

PART 3 - EXECUTION

3.1 PREPARATION
A. Proof roll prepared base material surface to check for unstable areas in accordance with Section 31 20 00 including documentation and re-proof rolling as required. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.
B. Remove loose material from compacted base material surface immediately before applying prime coat.
C. Establish and maintain required lines and elevations.
D. Cover the surfaces of curbs, gutters, manholes and other structures on which the asphaltic concrete mixture will be placed, with a thin, uniform coat of liquid asphalt. Where the asphaltic concrete mixture will be placed against the vertical face of an existing pavement, clean the vertical face to remove foreign substances and apply a coating of liquid asphalt at a rate of approximately 0.25 gallons per square yard.

3.2 APPLICATION
A. Prime Coat:
   1. Apply to base material surfaces at least 24 hours in advance.
   2. Apply in accordance with state highway department specifications.
   3. Apply at minimum rate of 0.25 gal per sq. yd over compacted base material. Apply to penetrate and seal, but not flood surface.
   4. Take necessary precautions to protect adjacent areas from over spray.
   5. Cure and dry as long as necessary to attain penetration of compacted base and evaporation of volatile substances.
B. Tack Coat:
   1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or Portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.
   2. Apply tack coat to asphaltic concrete base course or sand asphalt base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphaltic concrete and sand asphalt bases and on surface of bases where asphaltic concrete paving will be constructed.
   3. Apply tack coat in accordance with state highway department specifications.
   4. Apply at minimum rate of 0.05 gal per sq. yd of surface.
   5. Allow drying until at proper condition to receive paving.

3.3 ASPHALTIC CONCRETE PLACEMENT
A. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Spread mixture at following minimum ambient temperatures:
   1. Between 40 and 50 F: Mixture temperature: 285 F
   2. Between 50 and 60 F: Mixture temperature: 280 F
   3. Higher than 60 F: Mixture temperature: 275 F
B. Whenever possible, spread pavement by finishing machine; however, inaccessible or irregular areas may be placed by hand methods. Spread hot mixture uniformly to required depth with hot shovels and rakes. After spreading, carefully smooth hot mixture to remove segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be type designed for use on asphalt mixtures. Do not dump loads faster that they can be properly spread. Workers shall not stand on loose mixture while spreading.
C. Paving Machine Placement: Apply successive lifts of asphaltic concrete in transverse directions with surface course placed parallel to flow of traffic. Place asphaltic paving in typical strips not less than 10'-0" wide. Asphaltic concrete paving, including base and surface course, shall be placed in one or more equal lifts for each Type as follows:
   1. TxDOT Type B (Base Course) – Min. 2.50", Max. 5.00" lift thickness
   2. TxDOT Type D (Surface Course) – Min. 1.50", Max. 3.00" lift thickness
D. Joints: Make joints between old and new pavements, or between successive days and work in manner that will provide continuous bond between adjoining work. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete course. Clean contact surfaces of joints and apply tack coat.

3.4 ROLLING AND COMPACTION
A. After being spread, mixture shall be compacted by rolling as soon as it will bear the weight of rollers without undue displacement. Number, weight, types of rollers, and sequences of rolling operations shall be such that the required density and surface are consistently attained while the mixture is in workable condition.
B. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.
C. Breakdown Rolling: Perform breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling with hot material.
D. Second Rolling: Follow breakdown rolling as soon as possible while mixture is hot. Continue second rolling until mixture has been thoroughly compacted as follows:
   1. Compact asphaltic base and surface course materials to contain 92 to 94 percent of the maximum theoretical dry density.
E. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.
F. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.
G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked. Any masked or marred finish surfaces shall be repaired or smoothed.

3.5 JOINTS
A. General
   1. Place each asphaltic paving layer as continuous as possible to keep the number of joints to a minimum. Create joints between old and new pavement, between successive days work, and where the mixture has become cold (less than 140 degrees F). Make these joints in such a manner as to create a continuous bond between the old and new pavement construction courses.
   2. Offset joint of successive courses by at least 6 inches.
B. Transverse Joints: If placing of material is discontinued or if material in place becomes cold, make a joint running perpendicular to the direction traveled by the paver. Before placement continues, trim the edge of the previously placed pavement to a straight line perpendicular to the paver and cut back to expose an even vertical surface for the full thickness of the course. When placement continues, position the paver on the transverse joint so that sufficient hot mixture will be spread in order to create a joint after rolling that conforms to the required smooth- ness. If the temperature of the previously placed pavement material drops below 140 degrees F before paving is resumed, give the exposed vertical face a thin coat of liquid asphalt just be- fore paving is continued.
C. Longitudinal Joints: Coat longitudinal joints that are not completed before the previously laid mixture has cooled to a temperature below 140 degrees F, with liquid asphalt just before paving is continued.

3.6 FIELD QUALITY CONTROL
A. Field quality control tests specified herein will be conducted by the Independent Testing Laboratory. The Contractor shall perform additional testing as considered necessary by the Contractor for assurance of quality control. Retesting required as a result of failed initial tests shall be at the Contractor’s expense.
B. Field testing, frequency, and methods may vary as determined by and between the Owner and the Independent Testing Laboratory.
C. Asphaltic surface and base courses shall be randomly cored at minimum rate of 1 core per
20,000 sq. ft of paving, but not less than 3 cores in light duty areas and 3 cores in heavy-duty areas shall be obtained. Cores shall be cut from areas representative of project and shall be tested for conformance with mix design.

D. Coring holes shall be immediately filled by the Contractor with full-depth asphaltic concrete.

E. Testing shall be performed on finished surface of each asphalt concrete course for smoothness, using 10'-0" straightedge applied parallel with, and at right angles to centerline of paved area. The following tolerances in 10 ft shall not be exceeded:
   Base Course Surface: 1/4-inch
   Wearing Course Surface: 1/8-inch

F. Thickness Test: Measure thickness of each core sample taken. The thickness of the course or the combined courses shall meet or exceed the indicated thickness. Where the deficiency exists, remove the affected pavement area and replace it with new pavement or, at discretion of Owner, correct deficient paving thickness with tack coat and minimum 1-in. overlay.

G. Field density test for in-place materials:
   1. Density tests shall be conducted on each core sample taken in accordance with ASTM D 1188 or D 2726 as applicable.
   2. In-place density tests by nuclear method in accordance with ASTM D 2950 shall also be taken as necessary to assure the specified density is obtained. Nuclear density shall be correlated with ASTM D 1188 or D 2726.

H. Laboratory Air Void: Mixture samples shall be taken at least four times for every 2000 tons or 8 hour day and compacted into specimens, using compactive blows (35, 50, or 75) equal to mix design per side with the Marshall hammer as described in AASHTO Test Method T 245 (ASTM D 1559). Temperature shall be equal to temperature at paving machine reheating. After compaction, the laboratory air voids of each specimen shall be determined.

I. Check surface areas as necessary to identify ponding areas. Remove and replace unacceptable paving as directed by Owner.

J. Asphalt Extraction and Aggregate Gradation: Asphalt extraction and gradation of extracted aggregate testing shall be performed in accordance with AASHTO TP 53 and ASTM D 5444 respectively. At least two extraction and two gradation tests shall be taken for each 2000 tons or each day pavement is placed.

K. Areas of deficient paving, including compaction, smoothness, thickness, and asphalt mixture, shall be delineated, removed, and replaced in compliance with Specifications requirements at no additional cost, unless corrected otherwise as directed and approved by the Owner.

L. The Contractor shall certify in writing that asphalt placement is in accordance with specification requirements.

END OF SECTION
SECTION 321400 - UNIT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Stone slabs set in mortar setting beds.

1.3 ACTION SUBMITTALS

A. Product Data: Provide 4’x2’ masonry sample with finish specified and grout joint
B. Sustainable Design Submittals: N/A
C. Samples: For each type of unit paver indicated
   1. Joint (grout) materials involving color selection.
   2. 4’x2’ Mock up with Thermal Flame surface finish.

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates: For Masonry Pavers, provide source, location, and information relative to product specification and procurement.

1.5 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
B. Weather Limitations for Bituminous Setting Bed: Install bituminous setting bed only when ambient temperature is above 40 deg F (4 deg C) and when base is dry.
C. Weather Limitations for Mortar and Grout:
   2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.
PART 2 - PRODUCTS

2.1 Leuders Limestone
   A. Leuders Limestone Slab: Grey Leuders
      1. Thickness: 2 inches
      2. Length: 4' slabs laid in lengths specified by Drawings
      3. Width: 6 inch, 12 inch, 18 inch, 24 inch in locations specified by Drawings
      4. Finish: All exposed Faces to be Thermal Flame Finish.

2.2 ACCESSORIES

2.3 MORTAR SETTING-BED MATERIALS
   A. Portland Cement: ASTM C 150/C Type II.
   B. Sand: ASTM C 144.
   C. Water: Potable.

2.4 GROUT MATERIALS
   A. High-Performance Cement Grout: ANSI A118.7, sanded.
      1. Polymer Type: Ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients.
   B. Grout Colors: As selected by Landscape Architect from product sample submittal.
   C. Water: Potable.

2.5 MORTAR AND GROUT MIXES
   A. General: Comply with referenced standards and with manufacturers’ written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.
   B. Mortar-Bed Bond Coat: Mix neat cement and water to a creamy consistency.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL.
   A. Cut Leuders Limestone with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
B. Joint Pattern: Running bond in all locations.

C. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) or 1/8 inch in 24 inches (3 mm in 600 mm) and 1/4 inch in 10 feet (6 mm in 3 m) from level, or indicated slope, for finished surface of paving.

3.2 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of masonry to finished grades indicated.

D. Mix and place only that amount of mortar bed that can be covered with limestone units before initial set. Before placing units, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

E. Wet limestone units before laying if the initial rate of absorption exceeds 30 g/30 sq. in. (30 g/194 sq. cm) per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

F. Place limestone before initial set of cement occurs. Immediately before placing on mortar bed, apply uniform 1/16-inch- (1.5-mm-) thick bond coat to mortar bed or to back of each masonry unit with a flat trowel.

G. Tamp limestone with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each slab in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

H. Spaced Joint Widths: all slabs to have 1/4” grout joint on all sides.

I. Cleaning: Remove excess grout from exposed slab surfaces; wash and scrub clean.

END OF SECTION 321400
SECTION 32 16 13
CURBS AND SIDEWALKS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Portland cement concrete curb, gutter, and sidewalk.
B. Related Sections
   1. Section 31 20 00 – Earthwork: Preparation of subgrades.

1.2 REFERENCES
A. American Concrete Institute (ACI)
   1. ACI 305R – Hot Weather Concreting
   3. ACI 308 – Standard Practice for Curing Concrete
   1. ASTM A 615 – Deformed and Plain Billet-Steel for Concrete Reinforcement
   2. ASTM C 94 – Ready-Mixed Concrete
   3. ASTM C 260 – Air-Entraining Admixtures for Concrete
   4. ASTM C 309 – Liquid Membrane-Forming Compounds for Curing Concrete
   5. ASTM C 920 – Elastomeric Joint Sealants
   6. ASTM D 994 – Preformed Expansion Joint Filler for Concrete (Bituminous)
   7. ASTM D 1190 – Concrete Joint Sealer, Hot Poured, Elastic Type
   8. ASTM D 1751 – Preformed Expansion Joint Fillers for Concrete Paving and Structural
      Construction (Nonextruding and Resilient Bituminous Types)
   9. ASTM D 2628 - Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements
C. Federal Specifications (FS)
   1. FS HH-F-341 – Fillers, Expansion Joint: Bituminous (Asphalt & Tar)
D. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and
   Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or
   on the Construction Drawings) to various item (or section) numbers from State DOT specifications are
   for purposes of additional information only; where conflicts may exist, the project specifications herein
   shall supersede the referenced State DOT specs. General requirements of the State DOT
   specifications as related to bid award, contract execution, scope of work, measurement and payment
   shall not be binding on this project unless otherwise specified in writing.

1.3 SUBMITTALS
A. Submit materials certificate from materials producer and Contractor, certifying that materials comply
   with, or exceed requirements specified herein to the Engineer and to the Independent Testing Laboratory
   for review and approval and within 7 calendar days after receipt of Notice-to-Proceed, submit for
   approval, certified laboratory test data or manufacturers certificates and data for the following items:
   1. Portland cement concrete mix
   2. Aggregate gradations
   3. Preformed expansion joint filler
   4. Field molded/poured sealant
   5. Dowel bars
   6. Expansion sleeves
   7. Tie bars
   8. Reinforcing steel bars
   9. Air entraining admixtures
   10. Water-reducing and set-retarding admixtures (if used)

1.4 QUALITY ASSURANCE
A. Establish and maintain required lines and elevations.
B. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner.

1.5 PROJECT CONDITIONS
A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 - PRODUCTS

2.1 MATERIALS
A. Concrete: Mix concrete and deliver in accordance with ASTM C 94.
   1. Design mix shall produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce following:
      a. Compressive Strength: 3,500 psi, minimum at 28 days, unless otherwise indicated on Construction Drawings.
      b. Slump Range: 2"-5" for hand placed concrete, 1-1/4" to 3" for machine placed (slipform) concrete
      c. Air Entrainment: 4 to 6 percent
   B. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. Forms shall be of depth equal to depth of curbing or sidewalk, and so designed as to permit secure fastening together at tops. Coat forms with non-staining type of coating that will not discolor or deface surface of concrete.
   D. Reinforcing Steel: Deformed steel bars, ASTM A 615, Grade 60.
   E. Portland Cement: Shall conform to ASTM C 150, Type I or II
   F. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with ASTM D 994, D 1751, D 2628; FS HH-F-341, Type II, Class A or approved equal.
   G. Joint Sealants (Hot-Poured): Conforming to ASTM D 1190, non-priming, self-leveling polyurethane.
      Acceptable sealants include:
      1. W.R. Meadows, Inc.: SealTight #164 or SealTight #1190
      2. Construction Chemicals: HJS-T6
   H. Joint Sealants (Cold-Poured): Conforming to ASTM C 920, Type S or Type M, Use T; non-priming, pourable, self-leveling polyurethane. Acceptable sealants include:
      1. Sonneborn: Sonolastic SL1 or Sonolastic SL2
      2. Tremco Commercial Sealants: Vulkem 45
      3. Sika Corporation: Sikaflex-1C or Sikaflex-2c
      4. Euclid Chemical Corporation: Eucolastic I or II
      5. W.R. Meadows, Inc.: Gardox
   I. Aggregate: ASTM C 33.
   J. Water: Clean and potable
   K. Dowel Bars: ASTM A 615, grade 60, and plain steel bars.
   L. Air Entraining Mixture: ASTM C 260. Acceptable products include:
      1. Sika Corporation: Sika AEA-14, Sika AEA-15, Sika AER or Sika AIR
      2. Euclid Chemical Corporation: Air Mix or AEA
      3. Construction Chemicals: ACOM-U8
   M. Curing Compound: ASTM C 309, Type 1. Acceptable products include:
      1. Sonneborn: Kure-N-Seal
      2. ChemMasters Corporation: Polyseal Plus
      3. Euclid Chemical Corporation: Aqua-Cure VOX or Super Aqua-Cure VOX
   N. Joint Backup Rods: Acceptable products include:
      1. Chase Construction Products: CEVA Rod 100
      2. W.R. Meadows, Inc.: SealTight Cera-Rod
3. Nomaco, Inc.: HBR XL Backer Rod

PART 3 - EXECUTION

3.1 PREPARATION
A. Begin paving work only after unsuitable areas have been corrected and are ready to receive paving. The subgrade beneath all sidewalks shall be scarified, moisture-conditioned and recompacted to at least 95 percent of the Standard Proctor maximum dry density. All sidewalks shall be constructed on minimum eight inches (8") of Select Fill as specified in Section 31 20 00.
B. Remove loose material from compacted base material surface to produce firm, smooth surface immediately before placing concrete.

3.2 INSTALLATION
A. Form Construction
1. Set forms to required grades and lines, rigidly braced and secured.
2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place minimum of 24 hours after concrete placement.
3. Check completed formwork for grade and alignment to following tolerances:
   a. Top of forms not more than 1/8-inch in 10'-0".
   b. Vertical face on longitudinal axis, not more than 1/4-inch in 10'-0".
4. Clean forms after each use and coat with form release agent as often as required to ensure separation from concrete without damage.
B. Reinforcement: Fasten reinforcing bars or welded wire fabric (if required) accurately and securely in place with suitable supports and ties. Remove from reinforcement all dirt, oil, loose mill scale, rust, and other substances that will prevent proper bonding of the concrete to the reinforcement.
C. Concrete Placement
1. Concrete shall be mixed and placed when the air temperature in the shade and away from artificial heat is a minimum of 35 degrees F and rising. Hot and cold weather concreting shall be in accordance with ACI 305R and 306R, respectively.
2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until set at required finish elevation and alignment.
3. Place concrete using methods that prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of reinforcing, dowels, and joint devices.
4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 1/2 hour, place construction joint. Automatic machine may be used for curb and gutter placement. Machine placement shall be at required cross section, line, grade, finish, and jointing as specified for formed concrete. If results are not acceptable, remove and replace with formed concrete as specified herein.
D. Joint Construction
1. Contraction Joints: Construct concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, in uniform sections of length specified on Construction Drawings. Form joints between sections either by steel templates, 1/8-inch in thickness, of length equal to width of curb and gutter, and with depth which will penetrate at least 2-inches below surface of curb and gutter; or with 3/4-inch thick perfomed expansion joint filler cut to exact cross section of curb and gutter; or by sawing to depth of at least 2-inches while concrete is between 4 and 24 hours old. If steel templates are used, they shall be left in place until concrete has set enough to hold its shape, but shall be removed while forms are still in place.
2. Longitudinal Construction Joints: Tie concrete curb or combination concrete curb and gutter, where specified on Construction Drawings, to concrete pavement with 1/2-inch round deformed reinforcement bars of length and spacing shown on Construction Drawings.
3. Transverse Expansion Joints: Concrete curb, combination concrete curb and gutter, or concrete sidewalk shall have filler cut to exact cross section of curb, gutter, or sidewalk. Joints shall be similar to type of expansion joint used in adjacent pavement.

E. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 1/2-inch or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in 1-piece lengths for full width being placed, wherever possible. Where more than 1 length is required, lace or clip joint filler sections together.

F. Joint Sealants: Install in accordance with manufacturer's recommendations.

3.3 CONCRETE FINISHING
A. After striking off and consolidating concrete, smooth surface by screeding and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10'-0" straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.

B. Work edges of sidewalks, gutters, back top edge of curb, and formed joints with edging tool, rounding edge to 1/2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and trowelling, when excess moisture or surface sheen has disappeared, complete surface finishing, as follows:
   1. Curbs, gutters, and sidewalks: Broom finish by drawing fine-hair broom across surface perpendicular to flow of traffic. Repeat operation as necessary to produce fine line texture.

C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up minor honeycombed areas. Remove and replace areas or sections with major defects as directed Owner.

D. Protect and cure finished concrete paving using acceptable moist-curing methods in accordance with "water-curing" section of ACI 308.

3.4 BACKFILL
A. After concrete has set sufficiently, spaces on either side of concrete curb, combination concrete curb and gutter, or concrete sidewalk shall be refilled to required elevation with suitable material compacted in accordance with Section 31 20 00.

3.5 CLEANING AND PROTECTION
A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

END OF SECTION
SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY
   A. Section Includes
      1. Painting and marking of pavements, curbs, guard posts, and light pole bases.

1.2 REFERENCES
   A. American Association of State Highway and Transportation (AASHTO)
      1. AASHTO M248 - Ready-Mixed White and Yellow Traffic Paints
   B. American Society for Testing and Materials (ASTM)
      1. ASTM D 4414 - Standard Practice for Measurement of Wet Film Thickness by Notched Gauges.
   C. Federal Specifications (FS)
      1. FS A-A-2886 - Paint, Traffic, Solvent Based (supersedes FS TT-P-85 and FS TT-P-115, Type I)
      2. FS TT-P-1952 - Paint, Traffic And Airfield Marking, Waterborne
   D. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or on the Construction Drawings) to various item (or section) numbers from State DOT specifications are for purposes of additional information only; where conflicts may exist, the project specifications herein shall supersede the referenced State DOT specs. General requirements of the State DOT specifications as related to bid award, contract execution, scope of work, measurement and payment shall not be binding on this project unless otherwise specified in writing.

1.3 PROJECT CONDITIONS
   A. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize flagmen, barricades, warning signs, and warning lights as required.

1.4 QUALITY ASSURANCE
   A. Use trained and experienced personnel in applying the products and operating the equipment required for properly performed work.

PART 2 - PRODUCTS

2.1 MATERIALS
   A. Paint shall be waterborne or solvent borne, colors as shown on Construction Drawings or as specified herein. Pavement marking paints shall comply with applicable state and local laws enacted to ensure compliance with Federal Clean Air Standards. Paint materials shall conform to the restrictions of the local Air Pollution Control District.
   B. Waterborne Paint: Paints shall conform to FS TT-P-1952
   C. Solvent Borne Paint: Paint shall conform to FS A-A-2883 or AASHTO M248. Paint shall be non-bleeding, quick-drying, and alkyd petroleum base paint suitable for traffic-bearing surface and be mixed in accordance with manufacturer's instructions before application for colors White, Yellow, Blue, and Red.

PART 3 - EXECUTION

3.1 EXAMINATION
   A. Examine the work area and correct conditions detrimental to timely and proper completion of the work. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION
   A. Sweep and clean surface to eliminate loose material and dust.
B. Where existing pavement markings are indicated on Construction Drawings to be removed or would interfere with adhesion of new paint, a motorized abrasive device shall be used to remove the markings. Equipment employed shall not damage existing paving or create surfaces hazardous to vehicle or pedestrian traffic. Within public rights-of-way, appropriate governing authority shall approve method of marking removal.
C. New pavement surfaces shall be allowed to cure for not less than 30 days before application of marking materials.

3.3 CLEANING EXISTING PAVEMENT MARKINGS
A. In general, markings shall not be placed over existing pavement marking patterns. Existing pavement markings, which are in good condition but interfere or conflict with the newly applied marking patterns, shall be removed. Deteriorated or obscured markings that are not misleading or confusing or do not interfere with the adhesion of the new marking material do not require removal. Whenever grinding, scraping, sandblasting or other operations are performed, the work shall be conducted in such a manner that the finished pavement surface is not damaged or left in a pattern that is misleading or confusing. When these operations are completed the pavement surface shall be blown off with compressed air to remove residue and debris resulting from the cleaning work.

3.4 APPLICATION
A. Apply two coats of paint at manufacturer’s recommended rate, without addition of thinner, with maximum of 100 square feet per gallon or as required to provide a minimum wet film thickness of 15 mils and dry film thickness of 7 ½ mils per coat. Paint shall be applied for a total dry film thickness of 15 mils. Apply with mechanical equipment to produce uniform straight edges. At sidewalk curbs and crosswalks, use straightedge to ensure uniform, clean, and straight stripe.
B. Install pavement markings according to manufacturer’s recommended procedures for the specified material.
C. Following items shall be painted with colors noted below:
   1. Pedestrian Crosswalks: White
   2. Light Pole Bases and Guard posts: Yellow
   3. Fire Lanes: Red or per local code
   4. Lane Striping where separating traffic moving in opposite directions: Yellow
   5. Lane Striping where separating traffic moving in the same direction: White
   6. ADA Symbols: White on Blue background, or per local code
   7. Parking Stall Striping: Yellow, unless otherwise noted on Construction Drawings

3.5 FIELD QUALITY CONTROL
A. Inspection: After the paint has thoroughly dried, visually inspect the entire application and touch up as required to provide clean, straight lines and surfaces throughout.
B. Testing: Testing of wet film thickness shall be performed a minimum of two times on each parking row (including striped islands) and pedestrian cross walks, and a minimum of one test on each lane/alignment striping. At least one test shall be performed after refilling paint striping machine, changing operators of striping machine, and changing paint types, brands, etc. This shall be performed in addition to the testing stated above. These tests shall be performed on each coat applied. Testing shall be performed in accordance with ASTM D 4414.

3.6 CLEANING
A. Waste materials shall be removed at the end of each workday. Upon completion of the work, all containers and debris shall be removed from the site. Paint spots upon adjacent surfaces shall be carefully removed by approved procedures that will not damage the surfaces and the entire job left clean and acceptable.

END OF SECTION
IRRIGATION SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Installation of underground, automatically controlled irrigation system, including electrical connections, connections to water mains, and necessary accessories.

1.2 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) latest edition
   1. D2239 Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter
   2. D2241 Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
   3. D2564 Solvent Cement for poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings
   4. D2609 Plastic Insert Fittings for Polyethylene (PE) Plastic Pipe
   5. D2855 Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings

B. National Fire Protection Agency (NFPA) latest edition
   1. 70 National Electrical Code (NEG)

1.3 QUALITY ASSURANCE

A. Report to the Irrigation consultant any deviations between the irrigation plan, technical specifications, and the site which may cause issues with inadequate or excessive coverage and/or general performance of the system. Failure to do so prior to installation of equipment which subsequently requires replacement, relocation, or modification shall be done solely at the Contractor's expense.

B. All local, municipal, and state laws, ordinances, codes and regulations relating to, or governing of, any portion of this work are hereby incorporated into and made a part of these specifications and shall be fully carried out by the Contractor. Anything contained in these specifications shall not be construed to conflict with any of the above rules, regulations, and requirements. However, when these specifications and drawings call for or describe materials, workmanship, or construction of a better quality, higher standard, or larger size than is required by the above rules and regulations, these specifications and drawings shall take precedence.

C. Permits needed for construction of the work included in this contract which are required by any legally constituted authority having jurisdiction, shall be obtained, Contractor shall pay for all costs in connection with permits and inspections required by such authorities. The Owner's representative shall be notified when these inspections are required. Any additional work to be done as a result of these inspections shall be performed at the Contractor's expense.

D. Manufacturer's directions and detailed drawings shall be followed in all cases where the manufacturers of components used in this system furnish directions covering points not shown in the drawings and specifications.

E. Due to the scale of the drawings and nature of the work it is not possible to indicate all offsets. Fittings, pipe sizing, etc. which may be required. The Contractor shall carefully investigate the structural and finished conditions affecting all work and plan work accordingly to meet such conditions. Drawings are generally diagrammatic and indicative of the work to be installed. The work shall be installed in such a manner as to avoid conflicts between system performance and the development as a whole.

F. The Contractor shall not willfully install the irrigation system as shown on the drawings when it is questionable in the field that obstructions, grade differences or discrepancies exist that might not have been considered in the design. Such obstructions or differences should be brought to the attention of the Owner's representative. In the event this notification is not performed, the irrigation contractor shall assume full responsibility for any revisions necessary.

G. Following installation, make final adjustments to lawn irrigation system prior to Owner's
1. Flush system completely, with nozzles and screens removed, to extract debris.
2. Verify sprinkler operation and alignment for direction of throw. Correct as necessary at no additional cost to the Owner.
3. Check pop-up spray nozzles for proper arc of spray with no overthrow onto pavement. Adjust nozzles as necessary for proper throw with no additional cost to the Owner.
4. Insure uniform distribution exists.
5. Insure proper sprinkler head operation after landscaping and/or sod installation.

H. Following final adjustment. Operate entire installation to demonstrate complete and successful operation of equipment. Programming 1 operation of the system which exceeds manufacturer's recommendations voids all design responsibility to the Irrigation consultant.

I. The Guarantee (warranty) submitted under this specification shall not deprive the Owner of other rights or remedies that the Owner may have under other provisions of the Contract Documents and is in addition to and is in force concurrently with other warranties made by the Contractor under requirements of the Contract Documents. Installation shall be warranted for 1 year from date of final acceptance for the following:
1. Defects in material, equipment, and workmanship of materials.
2. Manufacturer warranties shall not relieve the Contractor of his liability under the guarantee. Such warranties shall only supplement the guarantee.
3. Activities with no additional costs to Owner shall include: adjusting irrigation heads and valve boxes level to finish grade, adjusting heads perpendicular to the finish grade, filling trenches that have settled 0.5” or more, compacting soil firmly around heads and valve boxes. Warranty action shall be completed at regular time intervals as agreed upon by both the Contractor and Owner.
4. Repair of damage to premises resulting from leaks or other defects in material, equipment, and workmanship to satisfaction of Owner.
5. Required warranty coverage does not include alterations to the system necessitated by additional landscaping, tree planting, grading, or changes to pavement or structures after final acceptance of the project by the Owner.

J. Basis of Payment:
1. The irrigation system includes the required installation of control systems, pumping systems, accessory and operating equipment that must include all materials, installation labor. Overhead/profit and the cost of required warranty and record documents. This system shall be bid as a lump sum price with a unit price schedule accompanying such bid.

1.4 SUBMITTALS

A. Component Submittal:
1. Do not proceed with purchase or installation of materials prior to receipt of approved submittals from Owner.
2. Provide one hard copy & one digital copy of each component specified per plan and/or herein
   For system designer to review.
3. Material list shall include the manufacturer, model number, and description of all materials to be used.
4. Each submittal set shall include a cover page to accept approval stamps and include the submittal number, project type, project location, contractor name and contact.
5. Equipment or materials installed or furnished without prior approval of the designer may be rejected and required to remove such materials from the site at the Contractor's expense.

B. Substitutions shall be made only with written approval of Owner. Substitutions will not be considered prior to opening of bids.
1. Substitutions shall include descriptive catalog literature, performance charts and/or flow charts.
2. Each substitution proposed shall include a written statement indicating the differences of operation and performance.
3. Substitution of specified irrigation heads after awarding of bid shall require piping diagram noting revised pipe sizes, pressure loss calculations, and head locations.
necessary to achieve desired watering provided by system as shown on Construction Drawings.

4. Provide 1 hard copy & one digital copy each of product data for requested substitutions to Owner for review.

C. Static and Dynamic Water Pressure Test.
   1. These tests are required with results provided to Irrigation consultant. The water source for this project is indicated on the Construction Documents. The static pressure (if known) and necessary design pressure are also provided thereon.
   2. If the pressure reading obtained by the Contractor is different than indicated and cannot satisfy the necessary design pressure, contact the Irrigation consultant immediately before proceeding or ordering of equipment. Failure to do so will hold the Contractor solely responsible for required alterations to the system to fit the available water source.

D. Project Record Documents and Final Punchlist
   1. Provide complete Project Record Documents to Irrigation consultant for review and use in Final Punchlist. All documents will be returned to Contractor with Final Punchlist for "walk through" with the Owner of the irrigation system.
   2. Within ten (10) days of receipt to the office responsible for irrigation design. Irrigation consultant shall attempt to perform Final Punch list and submit written response within four (4) days of the inspection to the Prime consultant.

E. Written Warranty
   1. Provided to Owner which meets or exceeds the requirements under QUALITY ASSURANCE.

1.5 PROJECT RECORD DOCUMENTS

A. As-built drawings: 2 sets, noting actual system pressure and exact locations and changes in a different color to the Construction Drawings.
   1. Include dimensional locations of each major component noted below from two (2) permanent fixed points such as building corners, light poles, fire hydrants, manholes, etc.
   2. Minimum components to be located and dimensioned include:
      a. Point of connection, meter, isolation valve, backflow device.
      b. Irrigation mainline alignment and sleeves
      c. Isolation gate valves and quick coupling valves.
      d. Control (electric) wire splice boxes and routing.
      e. Air and vacuum relief valves.

B. Operation Manual: 2 copies, bound in three ring binders, indexed and tabbed for easy reference, and labeled on spine and cover. Manual is to include following:
   1. Installing company name, address, phone/fax number, and list of principal owner(s).
   2. Material suppliers name, address, phone/fax number.
   3. Approved submittals as specified herein.
   4. Operating Instructions:
      a. Winterization
      b. Recommended operation sequence, frequency, and length of operation cycle, as Rate, and anticipated flow.
   5. Maintenance Instructions:
      a. Manufacturers' product data, installation, and maintenance instructions that list and recommend frequency of service to specific components.
      b. Parts Manufacturers' warranties for all equipment installed shall be provided to Owner.
      c. Copies of completed warranty information. Contractor to complete and mail necessary warranty registration information to manufacturer with copies provided to Owner.
      d. Provide a Maintenance Checklist containing the signature of the irrigation system owner or Owner's representative, the irrigator's seal, signature and
date, and a statement confirming that “The irrigation system has been installed in accordance with applicable state and local laws, ordinances, rules, regulations or orders. I have tested the system and determined that it has been installed according to the Irrigation Plan and is properly adjusted for the most efficient application of water at this time”.

C. Controller Chart: Prepare color coded chart, reduced in size, containing same plan information as As-Built drawings, and laminated in plastic on both sides, with following specific information:
   1. Identify valves as to size, station number shown on controller, and type of irrigation head (e.g. spray, rotor, drip) on each valve.
   2. Delineate each station's limits of coverage by color-coding, with each station having different color showing its zone with zone number designation.

D. Copies of necessary permits and inspection tags to justify governing approvals.

1.6 PROJECT CONDITIONS

A. Visit site and become familiar with nature and location of work, existing conditions, and conditions that will exist during installation.

B. If irrigation work is part of General Construction Contract, then meter and backflow device shall be provided and permitted by Utility Subcontractor in accordance with Section 331100. If irrigation work is not part of General Construction Contract, General Contractor shall contract with and pay local utility company, including meter deposit, to tap water main and install meter(s) required. Backflow device shall be provided and permitted as described herein.

C. Verify and coordinate necessary electrical and phone connections for system operation.

D. Any irrigation work surrounding preserved vegetation shall closely follow the layout as presented on the plans except when it is purposely shown in a hardscape area for graphic clarity. If the planned preservation area is considered threatened, full irrigation coverage may not be shown or warranted.

1.7 QUALIFICATIONS

A. Licensed irrigation contractor in good standing with the governing state agency and a minimum of 5 consecutive years’ experience in area of project and having installed other jobs of similar size and scope with verifiable post-installation warranty performance.

B. The irrigation foreman installing the project must attend the pre-construction meeting to coordinate with associated trades and review the plans and specifications. Irrigation foreman shall also remain on the project throughout installation until Substantial Completion has been issued for the system. Failure to maintain this individual on the project site without Owner approval, excluding events beyond control (health, resignation, etc.) will subject installing contractor to a one-time penalty of $5,000 to be deducted from the contract retainage.

C. Provide minimum of 3 references and list of similar projects with owner's names, addresses, and telephone numbers, when requested by Owner.

1.8 MAINTENANCE

A. Once each month, for first 6 months of operation following Final Acceptance, provide on-site consultation with Owner's operating personnel. This shall include up to 4 hours' time each month.

PART 2 PRODUCTS

2.1 GENERAL

IRRIGATION SYSTEMS 328000-5
A. Acceptable manufacturers of specialized components shall include:
   1. RainBird Corporation
   2. HUNTER Industries, Inc.
   3. NETAFIM USA
   4. Owner Approved two-wire and/or central control providers

2.2 PIPE

A. Polyvinyl Chloride (PVC): Pipe over 1 inch diameter shall conform to ASTM D2241. SDR 21, and Class 200.

B. Polyvinyl Chloride (PVC): Pipe 1-inch diameter and under shall conform to ASTM D2241. SDR 13.5, and Class 315.

C. Flexible Polyethylene (PE): Pipe shall conform to ASTM D2239. SDR 11.5, PE23, rated at 100 PSI. National Sanitation Foundation (NSF) approved. Subject to approval of Owner, shall be utilized for laterals in areas where ground is subject to freezing for extended periods of time each year.

D. Pipe sizes 2 1/2-inch or smaller shall have bell and socket joints that are solvent welded.

E. Pipe sizes larger than 2 1/2-inch shall have snap connections with rubber gasket joints. Thrust blocking shall be required in accordance with Section 32 11 00.

F. Pipe used to sleeve below paved areas shall conform to ASTM D2241. Schedule 40. Minimum diameter of 2-inch or 2 sizes larger than pipe scheduled to pass through the sleeve.

G. All polyvinyl chloride (PVC) pipe must bear the following markings:
   1. Manufacturer's name
   2. Nominal pipe size
   3. Schedule of class
   4. Pressure rating in pounds per square inch (PSI)

2.3 FITTINGS

A. Plastic Fittings:

   2. Flexible Polyethylene (PE) Lateral Line Fittings: Fittings shall conform to ASTM D2609. Type 1 PVC insert fittings designed for used with this type of pipe. Pipe and fittings shall be joined with stainless steel pinch clamps or worm gear clamps, including stainless steel screw.

   3. Risers above finished grade shall be black in color or receive 2 coats of black exterior semi-gloss enamel paint if a color other than black.

B. PVC Primer Solvent and Cement: Pipe and fittings shall be primed with a colored primer prior to applying PVC cement in accordance with the Uniform Plumbing Code (Section 316) or the International Plumbing Code (Section 605). Cement shall conform to ASTM D2564.

C. Swing Pipe Connections: Connections between spray heads to lateral piping shall be thick wall, flexible, polyethylene pipe, with fittings that have male thread on one end and either male or female screw ends opposite. Glue fittings and female barb adapters are not allowed.

D. Swing Joint Connections: Connections between quick couplers to mainline; and rotor heads to lateral piping shall be rigid PVC with fittings that have street ells on each end.

2.4 BALL VALVES- 3-Inches or Smaller

A. Cut off or isolation valves shall be as manufactured by LASCO or approved equal.

B. Provide with each valve a valve key and cast iron cylindrical valve box with top.
2.5 ELECTRIC CONTROL VALVES

A. HUNTER ICV electric remote control valves or approved equal.

B. A master valve if indicated on the Construction Drawings shall be sized to diameter of leading mainline pipe and installed on the discharge side of the backflow prevention device and/or pressure pump system.

2.6 SPRINKLER HEADS

A. Full or part Circle Pop-Up Fixed Spray Sprinkler:
   1. If not specified on Construction Drawings, pop-up heights shall be:
      a. Turf- 4-inches
      b. Shrub and groundcover beds- 12-inches
   2. Acceptable Products:
      a. HUNTER Adjustable Arc Series nozzles or Pro-Spray Series nozzles with INST Series sprinklers having in-stem built-in pressure regulation and Check Valve (CV) features or approved equal.

B. Full or Part Circle Pop-up Gear Driven Rotor Sprinkler.
   1. Acceptable Products:
      a. HUNTER Rotor PGP Series. 1-20 or 1-25 Series, or 1-35 Series, with appropriate nozzles and check valve features or approved equal.
2.7 VALVE BOX
A. Valve boxes shall be manufactured by NOS or approved equal. No irrigation valve box shall be placed in pavement areas unless otherwise specified on the Construction Drawings.
   1. When used with single valve, provide Economy Turf Box with green colored locking cover.
   2. When used with 2 or more valves, provide Jumbo Box with 20-inch x 14-inch green locking cover opening with cover labeled “Control Valve”.
   3. When used for wire splice or isolation valve, provide round box with snap fit cover.
   4. When used for quick coupler devices, provide Economy Turf Box with purple colored locking cover.

2.8 AUTOMATIC CONTROLLER
A. Controller shall have wall mount, weatherproof, lockable cabinet with internal transformer. Acceptable products include:
   1. HUNTER PRO-C or ICC Series or approved equal.

2.9 WIRE
A. Number 18-size minimum copper wire, U.L. approved for underground direct burial.
   1. Colored control wire shall have same color-coding as visible in controller. Should multiple controllers be required, each controller shall utilize a unique color insulated wire.
   a. Approved two-wire systems shall conform to manufacture installation guidelines.
   2. Provide watertight connectors with sealant for wiring connections.
B. All 110 volt (or larger) wire required for this project shall be material as required by local code and installed to local code

2.10 CLIMATE SENSOR
A. Provide rain/freeze sensor to cancel operation of controller during substantial rainfall or low temperatures that could endanger the system, plant material, or the general public acceptable products include:
   1. Hunter wireless rain/freeze – CLIK system or approved equal.

2.11 BACKFLOW PREVENTOR
A. Comply with requirements and codes of the state and local governing authority regarding backflow prevention.
B. Provide the necessary materials, insulation/draining capabilities, vandal resistance, permanent foundation and insulated fiberglass enclosure, dark green in color unless otherwise dictated by local code.
C. Backflow preventer type shall be suitable for use in high hazard cross connection to potable water system as manufactured by Watts Regulator Company, Lawrence, MA • or approved equal:
   1. Reduced pressure backflow preventers shall be No. 909 series Reduced Pressure Principle Backflow Preventer, or approved equal.
   2. Double check valve assembly backflow preventers shall be No. 709 series Double Check Valve Assembly, or approved equal.
   3. In absence of local codes or requirements, double check assembly backflow preventer installed in strict accordance with manufacturer’s written instructions shall be considered as minimum requirements.
PART 3 EXECUTION

3.1 PREPARATION

A. Pressure/Flow Test: Conduct tests at the irrigation water tap or meter location and provide written results to Owner including the following information:
   1. Static pressure in psi
   2. Residual pressure in psi
   3. Flow in gpm

B. Prior to installation, receive approval from General Contractor to proceed with construction.

C. Contractor shall field verify all above ground and underground utilities prior to start of work.

D. Before trenching of the system is started, flag where each sprinkler head, quick coupler valve, mainline pipe, control valve, etc. to be located in accordance with the plans. Should a discrepancy in the plans become apparent at this time, in regard to size and/or shape of areas to be irrigated, such discrepancy shall be pointed out to the Owner or Owner’s representative.
   1. Should such changes create an increase or decrease in the Contract amount, the Owner shall approve such change in cost prior to commencement of work.
   2. Should the severity of the discrepancy make it necessary to consult the irrigation designer, cease work in the vicinity of the discrepancy until a resolution can be determined.
   3. Preserved trees shall be protected from trenching to the minimum extent of the canopy dripline. Should the planned preservation area be threatened by irrigation work, full irrigation coverage may not be warranted.

E. Traffic control barricades shall be provided as necessary in accordance with state highway Barricade standards for the protection of workers, pedestrians, bicycles, and vehicles.

F. All material shall be installed in accordance with manufacturer’s installation specifications and as shown on the drawing.

3.2 BACKFLOW PREVENTOR

A. Comply with state and local codes for installation of backflow preventer. In absence of local codes, minimum requirements shall be to set in accordance with manufacturer’s written instructions.

B. Provide combination of drains and quick coupler valves to accommodate winterization of entire system by forced air. Submit materials/methods to Owner for consideration and receive approval prior to installation of work.

C. Contractor shall ensure the backflow prevention device is tested prior to being placed in service and the test results provided to the local water purveyor and the Owner of the irrigation system within 10 business days of testing the backflow prevention device.

3.3 EXCAVATION

A. Excavate trench to proper depth.

B. Minimum trench width shall be 3 1/2-inches.

C. Backfill and hand tamp over excavation prior to installing piping.

D. Excavate trenches deeper than required in soils containing rock or other hard material that might damage pipe. Backfill to proper depth with selected fine earth or sand.

E. Keep trenches free of obstructions and debris that would damage pipe.
F. Avoid heating trenches, electric ducts, storm and sanitary sewer lines, water and gas mains when trenching for piping.

G. Do not cut sidewalks, paved areas, or curb and gutter when trenching for piping unless otherwise noted on the Construction Drawings.
   1. Provide sleeves (as specified in 2.2 F. above) under paving prior to installation of paving.
   2. Under existing paving, auger bore or tunnel without disturbing existing pavement above.

3.4 SLEEVES

A. Conduit from the controller room to the nearest exterior pervious area must include heavy gauge nylon pull cords.

B. Provide sleeves for both piping and control wiring where either passes under paved surfaces:
   1. Depths of sleeves shall be same as that required for piping at each location or condition.
   2. Extend sleeves 12-inches beyond paving at each end.
   3. Install permanent benchmark at top of curbs for reference to sleeve locations as detailed.

3.5 PIPING INSTALLATION

A. Inspect all pipe prior to installation. Pay particular attention to mechanical damage resulting from shipment, storage, and defects which might occur during extrusion. Such defective pipe shall be removed from the site at the end of each work day.

B. Do not lay pipe on unstable material or blocking, or when in opinion of Owner conditions are unsuitable. Rest full length of pipe section on bed of trench, excavating recesses to accommodate joints.

C. Minimum cover from top of piping to finished grade shall be provided as follows:
   1. Lawn and planting areas:
      a. Mains and Control Valves: 18-inches
      b. Laterals: 12-inches
   2. Drives or parking areas: 24 inches

D. Clearances: Minimum of 3-inches horizontal clearance between parallel lines in same trench or vertical clearance between lines crossing at angles.

E. Special Requirements- PVC and PE pipe:
   1. Snake in trench at least 1-foot per 100-feet of pipe to allow for thermal expansion.
   2. Pipe laterals to drain to low point drains located at lowest elevations of each zone.

F. Threaded Plastic Pipe:
   1. Do not use solvent cement on threaded joints.
   2. Wrap joints with Teflon tape or use virgin Teflon lubricant so that threads are filled.

G. PVC Fittings and/or Bell and Socket Pipe: Pipe and fittings shall be primed with a colored primer prior to applying PVC cement in accordance with the Uniform Plumbing Code (Section 316) or the International Plumbing Code (Section 605).
   1. Insure a square cut. Burrs at cut ends shall be removed prior to assembly and pipe ends must be tapered (shaved) so that a strong weld will take place.
   2. All solvent weld joints must receive color-tinted acetone cleaner/prime prior to solvent application. Apply this material sparingly to the inside of the fittings or pipe so that it does not run down inside the pipe.
   3. Apply a uniform coat of solvent to the outside of the pipe with a non-synthetic bristle brush.
   4. Apply solvent sparingly to the inside of the fitting in a similar manner using care not to allow the solvent to run down fitting into the pipe.
   5. Re-apply a light coat of solvent to the exterior of the pipe and quickly insert the pipe into the fitting.
   6. Give the pipe or fitting a quarter turn to insure even distribution of the solvent and make sure the pipe is inserted to the full depth of the fitting socket.
   7. Hold in position for a minimum of 15 seconds.
8. Wipe off excess solvent that appears at the outer shoulder of the fitting. The joints shall be allowed to set at least 24 hours before water pressure is applied to the system.

H. Metal to PVC joint: Install the metal connection first on PVC to metal joints. A non-hardening Teflon paste or tape shall be used on all threaded PVC to metal joints. Apply only light wrench pressure to tighten.

I. Concrete thrust blocks and valve anchors: On all irrigation mains (4” and larger) regardless of the joint style used, provide concrete thrust blocks at all changes in direction of the piping and at all cast-iron gate valves. Use 2,500 psi minimum strength concrete.
   1. Thrust blocks shall be formed by placing concrete between the pipe and an undisturbed trench wall. Thrust blocks shall be sized and so placed to take all the thrust created by the directional change of water within the pipe.
   2. The concrete thrust block shall not encase the pipe or valves.

J. All mainline pipe with control valves in-place shall be pressure tested at a minimum of 100 PSI as measured at the pump station for a two-hour period. Should the system not hold pressure, the leaks will be identified, repaired, and the system retested until it passes the above test.

3.6 VALVES

A. Do not locate beneath paved surfaces.

B. Install plumb to within 1/16-inch.

C. Locate level within valve box with 6-inch deep layer of coarse gravel beneath bottom of valve.

D. All systems must provide an Isolation Valve between the water meter and backflow prevention device.

E. Electric Control Valves:
   1. Position flow control handle in box to enable easy access for adjustment.
   2. Valve box is to rest on non-deteriorating supports and not on the inlet/outlet piping or control wires. Block the "cut-out" on the valve box to reduce the settlement of soil around the valve.
   3. Valves that may be grouped shall be in straight rows spaced a minimum of 18-inches apart and positioned 3-foot from any hardscape.

F. Quick Coupler Valves: (if provided on Construction Drawings):
   1. Top of quick coupling shall be 3-inches below top of purple valve box and supported both vertically and horizontally.
   2. Isolation valve must be installed upstream of the quick coupling connection such that both units are accessible and operational.
   3. Threaded hose connections can only be used through a quick coupling key and labeled as "non-potable, not safe for drinking".

G. Master Valve (if provided on Construction Drawings):
   1. Locate on the discharge side of the backflow prevention device and/or pressure pump system.
   2. Valve shall be energized by master valve circuit on automatic controller.

H. Cast Iron Isolation Valves (if provided on Construction Drawings):
   1. Installed with adjustable height valve boxes over each valve in the center of the square-nutted valve stem in the middle of the vertical riser of the valve box.

3.7 SPRINKLERS

A. Emission devices must be installed to operate at the optimum and not the minimum/maximum sprinkler head pressure as published by the manufacturer for the nozzle and head spacing that is used. Methods to achieve the water pressure requirements include, but not limited to, flow control valves, pressure regulators, or pressure compensating spray heads.

B. Install plumb to within 1/16-inch with top collar (not nozzle) flush to finish grade.
C. Provide swing assembly or flex pvc to each spray device and rigid o-ring swing joint to each rotor device, except where entire spray nozzle is raised above grade and/or where rigid riser piping is shown per plan.

D. Locate sprinkler between 4-inch and 6-inches from edge of paving or back of curb with flow directed away from adjacent impervious surface.

E. Above ground emission devices may not be used in areas that are less than 48-inches (unless exceeded by local code) not including the impervious surfaces in either length or width and which contain impervious pedestrian or vehicular surfaces along two or more perimeters.

F. All nozzles shall be checked for proper discharge and arc of operation. Adjust arc and/or change nozzle if necessary to fit site conditions at no extra cost to the Owner. Prevailing wind conditions and area to be covered will determine correct arc of spray. All spray nozzles and rotors must have filter screens installed and free of debris.

3.8 ELECTRICAL CONNECTIONS AND CONTROL WIRE

A. Shall be in strict accordance with latest edition of National Electrical Code (NEG) and local electrical codes. Necessary permits and inspection tags shall be provided with Project Record Documents.

B. Provide electrical connection to system as designated on Construction Drawings and as specified herein.

C. Permanent controllers and any temporary controllers shall be wired to a separate circuit breaker serving only that controller or bank of controllers. If a surge protection device is not specified within the electrical plans, an Intermatic AG2401 surge protection device shall be installed on the supply wiring prior to branching out to each controller.

D. Pressure pump systems as may be necessary for this project shall be installed with electrical components recommended by the manufacturer with dedicated electrical circuits to the pump device and controls.

E. General:
   1. Do not run control and power supply wiring in same conduit.
   2. Wiring shall be inspected before and during installation to avoid nicks and broken insulation.
   3. Install and cap one extra signal and common wire to the last control valve in all directions from each controller. This wire serves as a spare conductor to be used in an emergency situation or for connection to a future valve.
   4. Provide continuous runs of wire between controller and valves. Splices shall be made with
      One of following:
      a. Watertight below ground electrical junction boxes.
      b. Water-tight connectors, such as utilized for valves, and located within valve box for ease of locating. Random field splices between the controller and valve will not be allowed.
5. Bury control wire beside pipe in same trench. Bundle and tape together at not more than 25-foot intervals.

F. Expansion Loops: Constructed by wrapping wire around 1/2-inch diameter pipe to create coil. A 3-foot section of wire shall be used to create 12-inch coil with 6-foot section being used to create 24-inch coil.

1. Provide 12-inch coils at each wire splice, not including valves, and at each change of wire direction.
2. Provide 24-inch coils at each control valve and where each valve enters conduit for automatic controller.

3.9 AUTOMATIC CONTROLLER

A. Location and installation shall be as shown on Construction Drawings and approved by Owner prior to installation.

B. Provide rigid conduits for both power supply and control wiring.
   1. Control wire conduit shall extend to 18-inches below grade.
   2. Secure conduit to wall with anchors and screws.

C. Landscape or turf grow in requirements may necessitate the need for temporary controllers. Such requirements shall be met with means as determined by the contractor in accordance with local water guidelines and restrictions.

3.10 BACKFILLING

A. Sand or fine-grained soils should be used for initial backfill to sufficient depth to prevent damage to pipe from rocks or other debris during compaction of subsequent backfill.

B. Fill trench to within 3-inches of finish grade with excavated soil and compact.

C. Fill top 3-inches with existing topsoil in planting or turf areas and wheel roll until compaction of backfill is same as surrounding soil.

D. Grade backfilled trench uniform with surrounding grades.

3.11 COMPLETION OF SYSTEM INSTALLATION

A. Upon completion of the work, clean and remove from the project all surplus and discarded materials, temporary equipment and debris. Leave the project site in a neat and orderly condition. Surplus and waste materials shall be legally disposed.

B. Repair any damage to utilities, structures, or other improvements as a result of work related to the installation of the irrigation system, to its original condition at no cost to the Owner.

C. Affix to each automatic controller a permanent sticker with waterproof ink which contains the irrigator's name, state issued license number, company name, telephone number, and the date of warranty period.

D. Complete a Maintenance Checklist of the installed system which includes but is not limited to:
   1. The manufacturer's manual for the automatic controller if not included with the controller.
   2. A seasonal (spring, summer, fall, winter) watering schedule based on the either current/real time evapo-transpiration or monthly historical reference evapo-transpiration (historical ET) data, monthly effective rainfall estimates, plant landscape coefficient factors, and site factors.
   3. A list of components, such as the nozzle, or pump filters, and other such components; that require maintenance and the recommended frequency for the service.
   4. The statement; "This irrigation system has been installed in accordance with all applicable state and local laws, ordinances, rules, regulations, or orders. I have tested the system and determined that it has been installed according to the Irrigation Plan and is properly
adjusted for the most efficient application of water at this time."

E. Complete PROJECT RECORD DOCUMENTS.

F. Submit Maintenance Checklist and PROJECT RECORD DOCUMENTS to irrigation designer for Final Punchlist.

G. Upon completion of the Final Punchlist by the irrigation designer, all Project Record Documents submitted will be returned to the Contractor or Prime Consultant.

H. Contractor shall remediate all outstanding items and schedule a final "walk through" with the Owner or Owner’s representative to deliver PROJECT RECORD DOCUMENTS to the Owner and explain the operation of the system in accordance with TCEQ Chapter 344.63.

I. Upon acceptance, the Owner reserves the right to make repairs as necessary to keep the irrigation system in operating condition. The exercise of this right by the Owner shall not relieve the contractor of responsibilities under the terms of the guarantee.

END OF SECTION
PART 1    GENERAL

1.1    SECTION INCLUDES

A. Preparation and excavation of planting beds
B. Planting of trees, shrubs, sod, seed, and associated materials.
C. Edging Materials
D. Aggregate and Fieldstone Materials

1.2    REFERENCE STANDARDS

A. American National Standards Institute (ANSI)
   1. Z60.1 American Standard for Nursery Stock
B. American Sod Producer Association (ASPA)
C. American Nursery and Landscape Association (ANLA)

1.3    QUALITY ASSURANCE

A. No error or discrepancy in Construction Drawings or Specifications shall cause defective or inappropriate materials to be used or poor workmanship to be allowed.
B. Condition of new plant materials is responsibility of Landscape Contractor and shall be approved by Owner, Owner reserves right to inspect and reject plants at any time and place.
C. Measure plants when branches are in their natural position.
D. Trees and shrubs shall meet requirements for spread, height, or container size stated in Construction Drawings.
   1. Measurements are to be taken from ground level to average height of shrub and not to longest branch,
   2. Height and spread dimensions specified herein refer to main body of trees measured from Crown of roots to tip of top branch,
E. Caliper measurements shall be taken at point on tree trunk 4 8 inches above natural ground line for trees up to 2 inches in caliper.
F. If range of sizes is given, no plant shall be less than minimum size, and at least 50 percent of plants shall be as large as upper half of range specified,
G. Measurements specified are minimum size acceptable and, where pruning is required, are measurements after pruning.

1.5 SUBMITTALS

A. Before ordering or purchasing plant material, provide information for approval, if so requested.

B. Submit certification tags from trees, shrubs, sod, and seed verifying type and purity.

C. Notify Landscape Architect / Owner at least 48 hours in advance of anticipated delivery date of plant materials. Legible copy of invoice, showing kinds and sizes of materials included for each shipment, shall be furnished to Owner.

D. Inform Landscape Architect / Owner of date when planting shall commence.

1.6 PROJECT CONDITIONS

A. Work must be carried out only during weather conditions favorable to landscape construction and to the health and welfare of plants. Owner shall determine suitability of such weather conditions.

PART 2 PRODUCTS

2.1 PLANT MATERIALS

A. Plant material (trees and shrubs) shall conform to requirements of ANSI Z60.1 of rules and grading upgraded to meet the following:

1. Plants shall be of selected specimen quality, exceptionally heavy, symmetrical, tightly knit so trained or favored in their development and appearance as to be superior in form, number of branches, compactness and symmetry. Plants shall have normal habit or sound, healthy, vigorous plants with a well-developed root system.

2. Plants shall be free of disease, insect pests, eggs, or larvae.

3. Plants shall not be pruned before delivery.

4. Trees with abrasion of bark, sunscalds, disfiguring knots, or fresh cuts of limbs over 1 1/4-inch, which have not completely calloused, shall be rejected.

5. Plants shall be typical of their species or variety and shall have normal habit of growth and be legibly tagged with proper name. Plants shall have been grown under climatic conditions similar to those of site or have been acclimated to such condition for at least 2 years.

6. Root system of each plant shall be well-provided with fibrous roots. Parts shall be sound, healthy, vigorous, well-branched, and densely foliated when in leaf.

7. Plants designated ball and burlap may be substituted with container grown.

8. Plants installed as ball and burlap must be moved with root systems as solid units with balls of earth firmly wrapped with burlap and comply with the following:

   a. Diameter and depth of balls of earth must be sufficient to encompass fibrous root feeding systems necessary for healthy development of plant.

   b. No plant shall be accepted when ball of earth surrounding its roots has been badly cracked or broken preparatory to or during process of planting. Balls shall remain intact during all operations.

   c. Plants that cannot be planted at once must be heeled-in by setting in ground and covering balls with soil or mulch and then watering.

   d. Hemp burlap and twine is preferable to treated. If treated burlap is used, twine is to be cut from around trunk and burlap is to be removed.

9. Trunk of each tree shall be single trunk growing from single unmutilated crown of roots. No part of trunk shall be conspicuously crooked as compared with normal trees of same variety. Thickness of each shrub shall correspond to trade classification "No.1". Single-stemmed or thin plants shall not be accepted. Side branches must be generous, well-twigged, and plant as whole well-branched to ground. Plants must be in moist condition, free from dead wood, bruises, or other root or branch injuries.
2.2 TOPSOIL
A. Natural, friable, fertile, fine loamy soil possessing characteristics of representative topsoil in the vicinity that produces heavy growth.
B. Topsoil, pH range of 5.5 to 7.4 with 3 to 4 percent organic material minimum, free from subsoil, objectionable weeds, litter, sods, stiff clay, stones larger than 1-inch in diameter, stumps, roots. Trash, toxic substances, or any other material which may be harmful to plant growth or hinder planting operations.

2.3 COMPOST
A. Weed free and derived from a well-decomposed source of organic matter. The compost shall be produced using an aerobic composting process meeting CFR 503 regulations, including time and temperature data indicating effective weed seed, pathogen and insect larvae kill. The compost shall be free of any refuse, contaminants or other materials toxic to plant growth. Non-composted products will not be accepted. Test methods for the items below should follow USCG TMECC guidelines for laboratory procedures:
   1. PH- 5.0-8.0 in accordance with TMECC 04.11-A. "Electrometric pH Determinations for Compost"
   2. Moisture content of less than 60% in accordance with standardized test methods for moisture determination.
   3. Material shall be relatively free (<1% by dry weight) of inert or foreign man made materials.

2.4 SHREDDED HARDWOOD BARK MULCH
A. Mulch shall be of sufficient character as not to be easily displaced by wind or water runoff.
B. Mulch shall be twice shredded and dark brown in color. All material shall be from a single production source and shall present a uniform appearance throughout the project.

2.5 FERTILIZER
A. General: Fertilizer shall be a commercial product, uniform in composition, free flowing, and suitable for application with approved equipment. Fertilizer shall be delivered to the site in fully labeled original containers. Fertilizer which has been exposed to high humidity and moisture, has become caked or otherwise damaged making it unsuitable for use, will not be acceptable.
B. Initial Planting Application: Fertilizer for the initial planting application shall be of N-P-K ratio of 4-5-1 (19-26-5). The phosphorous component must be derived from monoammonium phosphate to stimulate vigorous development of new roots, stolons, and rhizomes. This initial application must be applied and incorporated into the soil immediately prior to sodding or planting.
   1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner’s approval.
C. Post Planting Application: Fertilizer for the post planting application will be a complete fertilizer of chemical base containing by weight the following percentages of nutrients: 27-3-4 +2% Fe (N-P-K) from methylene urea or the nitrogen equivalent of 33-3-10. The application rate should provide 1 lb. of N/1000 sq. ft.
   1. Specification Submittal: Submit a sample label or specification of the fertilizer proposed to be used for the Owner’s approval.

2.6 WATER
A. Potable water, on-site water shall be furnished by Owner. Landscape Contractor shall furnish hose and other watering equipment.
2.8 SOD

A. Hybrid Bermuda Sod: Turfgrass sod shall be 100% "Tifway 419 Bermuda" (Hybrid Bermuda grass). Sod shall consist of stolons, leaf blades, rhizomes and roots with a healthy, virile system of dense, thickly matted roots throughout the soil of the sod for a thickness not less than three-quarters (3/4") inch. Sod shall be alive, healthy, vigorous, free of insects, disease, stones, and undesirable foreign materials and grasses. The grass shall have been mowed prior to sod cutting so that the height of grass shall not exceed two (2") inches. Sod shall have been produced on growing beds of clay-loam topsoil. Sod shall not be harvested or planted when its moisture condition is so excessively wet or dry that its survival will be affected. All sod is to be harvested, delivered, and planted within a thirty-six (36) hour period of time. Sod shall be protected from exposure to wind, sun, and freezing. If sod is stacked, it shall be kept moist and shall be stacked roots-to-roots and grass-to-grass.

1.9 TREE STAKING MATERIAL

A. The root anchor underground tree staking system or approved equal.

2.10 STEEL EDGING

A. 3/16" unfinished steel edging to be welded at stakes and corners
   1. Specification Submittal: Submit a product sample for the Owner's approval

2.11 TREE WELL AGGREGATE

A. Material shall be 1/4 inch minus crushed Oklahoma silver mist gravel at a depth of 3 inches and compacted, to be approved by the owner and Landscape Architect.
   1. Specification Submittal: Submit a product sample for the Owner's approval

2.12 FIELD STONE

A. Material shall be 6 inch to 9 inch- Oklahoma Silver Mist - Irregular Field Stone. Exposed face to be dry stacked perpendicular to grade with a minimum of 6 inches exposed surface area above Grade.
   1. Specification Submittal: Submit a product sample for the Owner's approval.

PART 3 EXECUTION
3.1 PROTECTION

A. Before commencing work, trees and shrubs that are to be saved shall be protected from damage by placement of fencing as specified on construction drawings. Protective fencing to be approved by City of Tyler Arborist. No work may begin until this requirement is fulfilled.

B. In order to avoid damage to roots, bark, or lower branches, no truck or other equipment shall be driven or parked within drip line of any tree, unless tree overspreads paved area.

C. Use precautionary measures when performing work around trees, sidewalks, pavements, utilities, and other features either existing or previously installed.

D. Adjust depth of earthwork and topsoil when working immediately adjacent to aforementioned features in order to prevent disturbing tree roots, undermining sidewalks and pavements, and damage in general to other features either existing or previously installed.

E. Cover plants transported to project in open vehicles with tarpaulins or other suitable covers securely fastened to body of vehicle to prevent injury to plants. Closed vehicles shall be adequately ventilated to prevent overheating of plants. Evidence of inadequate protection following digging, carelessness while in transit, or improper handling or storage shall be cause for rejection. Plants shall be kept moist, fresh, and protected. Such protection shall encompass entire period during which plants are in transit, being handled, or are in temporary storage.

F. Where excavating, fill, or grading is required within drip line of trees that are to remain, work shall be performed as follows

1. Trenching: When trenching occurs around trees to remain, tree roots shall not be cut but trench shall be tunneled under or around roots by careful hand digging without injury to roots.

2. Raising Grades:
   a. Where fill not exceeding 16 inches is required, clean, washed gravel graded from 1 inch to 2 inches in size shall be placed directly around tree trunk. Extend gravel out from trunk on all sides minimum of 18 inches and finish approximately 2 inches above finished grade at tree. Install gravel before any earth fill is placed. New earth fill shall not be left in contact with trunks of trees requiring fill.
   b. Where fill exceeding 16 inches is required, construct dry-laid tree well around trunk of tree. Tree well shall extend out from trunk on all sides minimum of 3 feet and to 3-inches above finish grade. Place coarse-graded rock directly around tree well extending out to drip line of tree. Place clean, washed gravel graded from 1 inch to 2 inches in size directly over coarse rock to depth of 3 inches. Place approved backfill material directly over washed gravel to desired finish grade.

3. Lowering Grades: Existing trees in areas where new finish grade is to be lowered shall have regrading work done by hand to elevation indicated on Construction Drawings. Roots as required shall be cut cleanly 3 inches below finished grade and scars covered with tree paint. Trees marked for preservation that are more than 6 inches above proposed grades shall stand on broad rounded mounds and graded smoothly into lower level. Trees located more than 16 inches above proposed grades shall have dry-laid stone wall or other retaining structure as detailed on Construction Drawings constructed minimum of 5 feet from trunk. Exposed or broken roots shall be cut clean and covered with topsoil.

3.2 PREPARATION
A. If project completion date prohibits in-season planting, prepare for out-of-season seeding or sodding so that lawns shall be completed and ready for acceptance at time of project completion, without additional cost to Owner.

B. Provide sufficient tools and equipment required to carry out planting operation.

C. Locations containing unsuitable subsoil shall be treated by one or more of the following:
   1. Where unsuitability is deemed by Owner to be due to excessive compaction caused by heavy equipment and where natural subsoil is other than AASHTO classification of A6 or 7, loosen such areas with spikes, discing, or other means to loosen soil to condition acceptable to Owner. Loosen soil to minimum depth of 12 inches with additional loosening as required to obtain adequate drainage. Contractor may introduce peat moss, sand, or organic matter into the subsoil to obtain adequate percolation. Such remedial measures shall be considered as incidental, without additional cost to Owner.
   2. Where unsuitability is deemed by Owner to be due to presence of boards, mortar, concrete, or other construction materials in sub-grade and where natural subsoil is other than AASHTO classification of A6 or 7, remove debris and objectionable material. Such remedial measures shall be considered as incidental, without additional cost to Owner.
   3. Where unsuitability is deemed by Owner to be because natural subsoil falls into AASHTO classification of A6 or 7 and contains moisture in excess of 30 percent, then installation of sub-drainage system or other means described elsewhere in Specifications shall be used. Where such conditions have not been known or revealed prior to planting time and they have not been recognized in preparation of Construction Drawings and Specifications, then Owner shall issue pricing order to install proper remedial measures.

D. Perform planting operations at steady rate of work unless weather conditions make it impossible to work. No plant material shall be planted in frozen ground.

E. Disk, drag, harrow, or hand rake subgrade to depth of 4 inches and removed stones larger than 1-1/2 inches to provide bond for topsoil. Topsoil, which must be transported across finished sidewalks, shall be delivered in such manner that no damage will be done to sidewalks. Contractor shall be responsible for repair of such damage.

F. Before placing topsoil, rake subsoil surface clear of stones, debris, and roots. Compact topsoil to form layer with minimum depth of 2-inches in lawn areas and 6-inches in shrub beds. Place topsoil so that after final settlement there will be positive drainage conforming to elevations shown on Construction Drawings.

G. Tree and Shrub Preparation
   1. Dig bare-rooted shrubs with adequate fibrous roots. Cover roots of these plants with uniformly thick coating of mud by being puddled immediately after they are dug, or packed in moist straw or moss.
   2. Dig ball and burlap plants with firm natural balls of earth of diameter and depth to include fibrous roots.
   3. Protect roots or balls of plants at all times from sun and drying winds.
   4. Ball and burlap plants which cannot be planted immediately upon delivery shall be set on ground and protected with soil, wet moss, or other acceptable material. Heel-in bare rooted plants that cannot be planted immediately upon delivery. All shall be kept moist.
   5. Open and separate bundles of plants before roots are covered. Take care to prevent air pockets among roots. During planting operations, cover bare roots with canvas, hay, or other suitable material. No plant shall be bound with wire or rope at any time so as to damage bark or break branches.

I. Sod Bed Preparation: Grade areas to finish grade, filling as needed or removing surplus dirt, stones, debris, etc. and floating areas to smooth, uniform grade as indicated on Construction Drawings. Lawn areas are to be graded to drain.

3.3 TREE AND SHRUB PLANTING

A. Planting shall not proceed until all irrigation spray/rotor heads have been installed or flagged. The
location of any head shall govern over the location of plant material. Plant material shall be located to allow the unobstructed performance of irrigation heads.

B. Plants too large for 2 persons to lift in and out of holes shall be placed with sling. Do not rock trees in holes to raise.

c. If rock or other underground obstruction is encountered, Owner may require plant pits to be relocated, pits enlarged, or plants deleted from project.

D. Make adjustments in locations as directed. In event that pits or areas for planting are prepared and backfilled with topsoil to grade prior to commencement of lawn operations, they shall be so marked that when planting proceeds, they can be readily located. In case underground obstructions such as ledges or utilities are encountered, change location under direction of Owner without charge.

E. Holes for trees shall be at least 2 feet greater in diameter than spread of root system and at least 6 inches deeper than root ball. Holes for shrubs and vines shall be at least 12 inches greater in diameter than spread of root system and at least 2 feet deep.

F. During backfilling of tree holes and shrub beds with topsoil, manure, ground limestone (if soil tests indicate it is needed), and commercial fertilizer at rate of 3 pounds for trees up to 3 inches in caliper, 1 pound per inch caliper for larger trees, 6 ounces for small shrubs and 8 ounces for each shrub 4 feet or over shall be added as progress of work permits. Omit ground limestone and manure in case of acid soil plants. Manure, limestone, and fertilizer shall be thoroughly mixed with topsoil in planting operation, care being taken that manure does not come in immediate contact with roots.

G. Trees shall be planted in center of holes with the root ball placed minimum 1 inch above grade and maximum of 1 1/2 inches above grade.

H. Plants shall be planted in center of holes and at same depth as they had previously grown. Backfill topsoil in layers of not more than 8 inches and each layer watered sufficiently to settle before next layer is placed. Tamp loam under edges of balled plants. Use enough topsoil to bring surfaces to finish grade when settled.

1. Provide saucer around each plant as shown on Construction Drawings.
2. Soak plants with water twice within first 24 hours after time of planting. Apply water with low pressure so as to soak in thoroughly without dislodging topsoil.

3.5 SOD

A. SOLID SOD

1. Laying sod: Prior to laying the sod, the planting bed shall be raked smooth to true grade and moistened to a depth of four (4") inches, but not to the extent causing puddling. The sod shall be laid smoothly, tightly butted edge to edge, and with staggered joints.
2. Rolling: The sod shall be pressed firmly into contact with the sod bed by rolling so as to eliminate all air pockets, provide a true and even surface, and insure knitting without displacement of the sod or deformation of the surfaces of sodded areas.
3. Smoothing: Following compaction, fine screened soil of good quality shall be used to fill all cracks between sod sections. Excess soil shall be worked into the grass with suitable equipment and shall be well watered. The quantity of fill soil shall be such that it will cause no smothering of the grass.

B. PROTECTION

No heavy equipment shall be moved over the planted turf area unless the soil is again prepared. Graded, leveled, and replanted. It will be the responsibility of the Contractor to protect all paving surfaces, curbs, utilities, plant materials, and any other existing improvements from damage. Any damages shall be repaired or replaced at no cost to the Owner. The Contractor will also locate and stake all irrigation heads, valve risers, etc., prior to beginning any soil preparation work.

C. FERTILIZING

1. Initial Planting Application: The fertilizer shall be applied at the rate of nine (9) pounds per one thousand (1000) square feet (400 pounds per acre).
   a. Timing: The initial planting application of fertilizer shall be applied over sodded areas
after planting, but not more than two (2) days later.

2. Post Planting Application: Thirty (30) days after planting turfgrass areas shall receive the specified post planting fertilizer at the rate of one (1) pound of nitrogen per one thousand (1000) square feet (45 pounds per acre).
   b. Timing: The Owner or his representative will determine if it is too late in the growing season for the post planting application. In the event that it is, the application shall be made in the spring of next year, or the cost of the application may become a credit due to the Owner.

3. Post Planting Maintenance: Areas without a uniform stand (complete coverage) that must be maintained later than thirty (30) days after the initial planting shall receive subsequent applications of fertilizer, as described above, every thirty (30) days until a uniform stand is achieved.

3.6 FIELD STONE

A. Site Preparation
   1. Areas to receive field stone shall be cleared of trash and debris. Weeds shall be removed to the ground.
   2. After clearing, areas to receive field stone shall be excavated to the depth shown on the plans.
   3. Prior to placement of field stone, the subgrade surface shall be smooth, firm, stable and free of rocks, clods, foliage, roots or other material greater than 1" in diameter.

B. Placement
   1. 5oz. Weed control fabric shall be placed in areas to receive field stone as recommended by the manufacturer and as specified herein. Weed control mat shall be placed loosely with longitudinal and transverse joints overlapped 4" and stapled to the subgrade at 6" on center. Staples shall be driven perpendicular to the ground surface. Following placement, the fabric shall lay flat, smooth and be in uniform contact with the soil surface, without bulges or wrinkles.
   2. After fabric, field stone to be dry stacked across surface area shown on plan. Fabric to be completely obscured by stone. Exposed field stone face along pavement or steel edge to be stacked perpendicular to grade with a minimum of 6 inches exposed surface area above grade.

3.7 STEEL EDGING

B. Placement
   1. 3/16 inch steel edging to be aligned at 90 degree angles with adjacent beds and paving. Stakes to be placed at regular intervals to maintain a straight line at each section of edging. Stakes to be tack welded, and corners to be welded and ground smooth to maintain solid and complete connection. Paint Color Finish to be determined by Owner.

3.8 MISCELLANEOUS INSTALLATIONS

A. Use compost for planting soil mixture only and not be used as mulch, except on specified ground covers.
   1. Use 3-4 inches of approved compost blend tilled into the top 12" of bed area in conjunction with the required 6" of topsoil and approved fertilizer.
B. Shredded Hardwood Bark Mulch
1. Apply 2 inches of shredded hardwood bark mulch or approved equal as top dressing in planting beds. Mulch single trees or shrubs to outside edge of saucer.

C. Edging shall be installed only where a hard surface does not exist to define a planting bed from adjoining turf and follow the alignment shown in the construction documents. Install edging with stakes on inside of bed. Backfill both sides to maintain form with the top of edging not exceeding finish turf grade by more than 1.0-inches. Edging shall maintain a consistent vertical position and terminate flush with hard surfaces with no sharp corners exposed.

3.8 MAINTENANCE DURING CONSTRUCTION
A. Begin maintenance immediately after planting. Plants shall be watered, mulched, weeded, pruned, sprayed, fertilized, cultivated, and otherwise maintained and protected until acceptance. Settled plants shall be reset to proper grade and position, planting saucer restored, and dead material removed and replaced. Tighten and repair stakes and wires. Correct defective work as soon as possible after it becomes apparent and weather and season permit.

B. Maintain lawns for at least 30 days after sodding and 60 days after seeding, or as long as is necessary to establish uniform stand of the specified grasses, or until substantial completion of project, or until acceptance of lawns, whichever is later.

c. In event that lawn operations are completed too late in Fall for adequate germination and/or growth, maintenance shall continue into following growing season or until uniform stand of specified grasses has been established.

D. Make weekly inspections to determine moisture content of soil and adjust watering schedule established by irrigation system installer to fit conditions.

E. After grass growth has started, areas that fail to show uniform stand of grass for any reason whatsoever shall be reseeded in accordance with Construction Drawings and as specified herein. Such areas shall be reseeded repeatedly until areas are covered with satisfactory growth of grass at no additional cost to Owner. Topsoil conditioning or removal and replacement shall be performed if required to facilitate establishment of grass at no cost to Owner.

F. Watering shall be done in such manner and as frequently as is deemed necessary by Owner to assure continued growth of healthy grass. Water areas of site in such a manner as to prevent erosion due to excessive quantities applied over small areas and to avoid damage to finished surface due to watering equipment.

G. Water for execution and maintenance will be provided by Contractor at no expense to Owner. Contractor shall furnish portable tanks, pumps, hose, pipe, connections, nozzles, and any other equipment required to transport water from available outlets and apply it to seeded areas in approved manner.

H. Initiate mowing of seeded areas when grass has attained height of 3 inches. Maintain grass height at 2 1/2 to 3 inches at subsequent cuttings depending on time of year. Not more than 1/3 of grass leaf shall be removed at any cutting and cutting shall not occur less than 10 days apart.
I. Heavy cuttings shall be removed to prevent destruction of underlying turf. If weeds or other undesirable vegetation threaten to smother planted species, such vegetation shall be mowed or, in case of rank growths shall be uprooted, raked and removed from area by methods approved by Owner.

J. Protect seeded area from pedestrian or vehicular trespassing while grass is germinating. Furnish and install fences, signs, barriers, or other necessary temporary protective devices. Contractor shall repair damage resulting from trespass, erosion, washout, settlement, or other causes at his expense.

K. Remove fences, signs, barriers, or other temporary protective devices after final acceptance.

L. If substantial number of plants are diseased, distressed, or dead at time of inspection, acceptance will not be granted and Landscape Contractor's responsibility for maintenance of plants shall be extended until replacements are made.

M. Replacements shall be plants of same variety and size specified on Construction Drawings. Furnish and plant as specified herein. Cost shall be borne by Contractor. Replacements resulting from removal, loss, or damage due to occupancy of project in any part, vandalism, physical damage by animals, vehicles, etc., and losses due to curtailment of water by local authorities will be approved and paid for by Owner.

N. Remove and replace dead, defective and/or rejected plant material and sod as required before final acceptance. Replacement of plant material that may be necessary shall be at expense of Landscape Contractor.

O. Grassed areas damaged during process of work shall be responsibility of Contractor, who shall restore disturbed areas to condition satisfactory to Owner. This may include filling to grade, fertilizing, seeding, and mulching.

P. Guarantee plants for period of 1 year after inspection and acceptance.

Q. At end of Establishment Period, inspection shall be made again. Remove from site any plant that is dead or unsatisfactory to Owner. Replace plants during normal planting season.

END OF SECTION
PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
   1. Site water piping and fittings including domestic potable waterline, fire protection system supply waterline, valves and fire hydrants.
B. Related Sections
   1. Section 31 20 00 – Earth Moving: Trenching, backfill, and compaction for utilities

1.2 REFERENCES
A. American Society of Mechanical Engineers (ASME)
   1. ASME B16.22 – Wrought Copper and Copper Alloy Solder Joint Pressure Fittings
B. American Society for Testing and Materials (ASTM)
   1. ASTM B 88 – Seamless Copper Water Tube
   2. ASTM D 1784 – Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds
   3. ASTM D 2241 – Poly (Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series)
   4. ASTM D 2564 – Poly (Vinyl Chloride) (PVC) Solvent Cement
   5. ASTM D 2672 – Poly (Vinyl Chloride) (PVC) Integrally Molded Bell Ends For Solvent - Cemented Pipe Joints.
   6. ASTM D 3139 – Joints for Plastic Pressure Pipes using Flexible Elastomeric Seals
   7. ASTM F 477 – Elastomeric Gaskets And Lubricant
   8. ASTM F 656 – Poly (Vinyl Chloride) (PVC) Cement Primer
C. American Water Works Association (AWWA)
   1. AWWA C105 – Polyethylene Encasement for Ductile Iron Pipe Systems
   2. AWWA C110 – Ductile-Iron and Gray-Iron Fittings for Water
   3. AWWA C111 – Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
   4. AWWA C151 – Ductile Iron Pipe, Centrifugally Cast, for Water
   5. AWWA C153 – Ductile Iron Compact Fittings for Water Service
   6. AWWA C504 – Rubber-Seated Butterfly Valves
   7. AWWA C509 – Resilient-Seated Gate Valves for Water Supply Service
   8. AWWA C515 – Resilient-Seated Gate Valves for Water Supply Service
   9. AWWA C600 – Installation of Ductile-Iron Water Mains and Their Appurtenances
10. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water
   11. AWWA C651 – Disinfecting Water Mains
   12. AWWA C800 – Underground Service Line Valves and Fittings
   13. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In., for Water Distribution
D. National Fire Protection Associations (NFPA)
   1. NFPA 24 – Installation of Private Fire Service Mains and Their Appurtenances

1.3 QUALITY ASSURANCE
A. Products, where marked for compliance with code or test standards, shall also mark specific standard as required in the Contract Documents.
B. Perform installation in accordance with utility company or municipality requirements.
C. Valves: Mark manufacturer's name and pressure rating on valve body.
D. Perform disinfection of potable lines in accordance with AWWA C651.

1.4 SUBMITTALS
A. Product Data: Provide Project Engineer with data on pipe materials, pipe fittings, hydrants, valves, and accessories.
B. Manufacturer's Certificate: Certify that products meet or exceed state or local requirements.
C. Furnish 1 copy of results of meter test and hydrostatic pressure test to Owner and utility company upon completion of water distribution backfilling operations.
D. Project Record Documents:
   1. Disinfection report: Record the following:
      a. Type and form of disinfectant used.
      b. Date and time disinfectant injection start and time of completion.
      c. Test locations.
      d. Initial and 24 hour disinfectant residuals (quantity in treated water) in ppm for each outlet tested.
      e. Date and time of flushing start and completion.
      f. Disinfectant residual after flushing in ppm for each outlet tested.
   2. Bacteriological report: Record the following:
      a. Date issued, project name, testing laboratory name, address, and telephone number.
      b. Time and date of water sample collection.
      c. Name of person collecting samples.
      d. Test locations.
      e. Initial and 24 hour disinfectant residuals in ppm for each outlet tested.
      f. Coliform bacteria test results for each outlet tested.
      g. Certification that water conforms, or fails to conform, to bacterial standards.
      h. Bacteriologist's signature and authority.
   3. Accurately record actual locations of piping mains, valves, connections, and top of pipe elevations.
   4. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

PART 2 - PRODUCTS

2.1 PIPE

A. Pipe sizes less than 4-inches that are installed below grade and outside building shall comply with one or combination of following, unless otherwise directed by local jurisdiction:
   1. Seamless Copper Tubing: Type "K" soft copper, ASTM B 88.
   2. Fittings: Wrought copper (95-5 Tin Antimony solder joint), ASME B 16.22.
   3. Polyvinyl Chloride (PVC) Water Pipe: Pipe, ASTM D 2241, with SDR 21 rating, continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 1784 material classification.
      b. Cement primer: ASTM F 656.
      d. Trace wire: Magnetic detectable conductor, (#12 Copper) brightly colored plastic covering imprinted with "Water Service" in large letters.

B. Pipe sizes 4-inches and larger that are installed below grade and outside building shall comply with one or combination of following, unless otherwise directed by local jurisdiction (note that all public water lines larger than 8 inches are required to be Ductile Iron in accordance with Tyler Water Utilities standard specifications):
   1. Gray Cast Iron Water Pipe: ANSI A21.6, thickness class 22, pressure class 150
      a. Fittings: Either mechanical joint or push-on joint, AWWA C110 or AWWA C11.
   2. Ductile Iron Water Pipe: AWWA C151, thickness class 50
      a. Fittings: Either mechanical joint or push-on joint, AWWA C110 or AWWA C111.
   3. Polyvinyl Chloride (PVC) Water Pipe: Pipe, AWWA C900, rated DR 18 (Class 150), continually marked as required (note that all public PVC water mains shall be SDR 14).
      a. Fittings: Ductile iron compact mechanical joint, AWWA C153.
2.2 VALVES

A. Gate Valves, 2-Inches and Larger:
   1. Manufacturer and Model: Mueller Resilient Wedge Gate Valves or approved equal, unless otherwise directed by local jurisdiction.
   2. AWWA C509 or C515, Iron body, non-rising stem with square nut, single wedge, resilient seat, class 150, flanged or mechanical joint ends, control rod, post indicator where indicated on Construction Drawings, extension box and valve key.

B. Ball Valves, 2-Inches and Smaller:
   1. Manufacturer and Model: Mueller Oriseal or approved equal, unless otherwise directed by local jurisdiction.
   2. Brass body, Teflon coated brass ball, rubber seats and stem seals, Tee stem pre-drilled for control rod, AWWA compression inlet end, compression outlet with electrical ground connector, with control rod, extension box and valve key.

C. Butterfly Valves, From 2-Inch to 24-Inch: AWWA C504, Iron body, bronze disc, resilient replaceable seat, water or lug ends, infinite position lever handle.

D. Check Valves, Post Indicator Valves, And Backflow Preventers
   1. Refer to Section 21 00 00 - Fire Suppression in Architectural/Building Specifications, when applicable, or as directed by local jurisdiction.

2.3 FIRE HYDRANTS

A. Fire Hydrants: Type as shown on Construction Drawings, unless alternate type is required by utility company or local Fire Department.

B. Hydrant Extensions: Fabricate in multiples of 6-inches with rod and coupling to increase barrel length.

C. Hose and Steamer Connections: Match sizes with utility company, with two hose nozzles, one pumper nozzle.

D. Finish: Apply primer and 2 coats of enamel or special coating to color as required by utility company.

2.4 ACCESSORIES

A. Thrust Blocking: Place 3000 psi concrete to provide sufficient bearing area to transmit unbalanced thrust from bends, tees, caps, or plugs to undisturbed soil without loading undisturbed soil in excess of 2,500 pounds per square foot when water main pressure is 100 psi.

MINIMUM THRUST BLOCKING BEARING AREAS

<table>
<thead>
<tr>
<th>PIPE DIAMETER</th>
<th>TEES S.F.</th>
<th>90° BEND S.F.</th>
<th>45° BEND S.F.</th>
<th>22 1/2° BEND S.F.</th>
<th>11 1/4° BEND S.F.</th>
<th>5 5/8 BEND S.F.</th>
<th>CAP/PLUG S.F.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3&quot;</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.5</td>
</tr>
<tr>
<td>4&quot;</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>2.0</td>
</tr>
<tr>
<td>6&quot;</td>
<td>1.5</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td>8&quot;</td>
<td>2.5</td>
<td>3.5</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>4.0</td>
</tr>
<tr>
<td>10&quot;</td>
<td>4.0</td>
<td>5.5</td>
<td>2.8</td>
<td>1.5</td>
<td>1.0</td>
<td>1.0</td>
<td>6.0</td>
</tr>
<tr>
<td>12&quot;</td>
<td>6.0</td>
<td>8.0</td>
<td>4.0</td>
<td>2.0</td>
<td>1.5</td>
<td>1.0</td>
<td>8.5</td>
</tr>
<tr>
<td>14&quot;</td>
<td>8.0</td>
<td>11.0</td>
<td>5.5</td>
<td>3.0</td>
<td>2.0</td>
<td>1.5</td>
<td>12.0</td>
</tr>
<tr>
<td>16&quot;</td>
<td>10.0</td>
<td>14.2</td>
<td>7.0</td>
<td>4.0</td>
<td>3.0</td>
<td>2.5</td>
<td>15.0</td>
</tr>
<tr>
<td>18&quot;</td>
<td>21.0</td>
<td>21.0</td>
<td>12.0</td>
<td>6.0</td>
<td>4.0</td>
<td>3.5</td>
<td>24.0</td>
</tr>
</tbody>
</table>
B. Locked mechanical joint fittings shall be installed where vertical changes in direction are required and, if approved by Owner and governing authority, can be installed in lieu of above thrust blocking requirements.
C. Polyethylene Encasement: Single layer of two ply cross-laminated high density polyethylene encasement per AWWA C105, meeting the following nominal specification: AWWA C105, Section 4.1.2, High Density Cross-Laminated Polyethylene Film, Type III, Class C (Black), Grade 33, tensile strength 5,000 psi minimum, elongation 100 percent, thickness nominal 0.004 inch (4 mil).

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that building service connection and municipal utility water main size, location, and depth are as indicated on Construction Drawings.

3.2 PREPARATION
A. Ream pipe and tube ends and remove burrs.
B. Remove scale and dirt, on inside and outside, before assembly.
C. Prepare pipe for connections to equipment with flanges or unions.
D. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and re-placed, as necessary, by same.

3.3 TRENCHING AND BEDDING
A. Excavate pipe trench and place bedding material in accordance with Section 31 20 00.
B. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.

3.4 INSTALLATION - PIPE AND FITTINGS
A. Maintain separation of water main from sanitary and storm sewer piping in accordance with state or local codes.
B. Install pipe and fittings in accordance with AWWA C600, AWWA C605 and/or AWWA C800 depending on material type.
C. Ductile iron pipe and fittings shall be installed with polyethylene tubing around the pipe for the entire length of the project except where water main is within steel casing or is concrete encased, if required by local utility company. Install polyethylene tubing in accordance with AWWA C105, Method A.
D. Install pipe to allow for expansion and contraction without stressing pipe or joints or as specified by pipe manufacturer.
E. Install access fittings in accordance with local codes to permit disinfection of water system per-formed under this Section.
F. Connections with Existing Pipelines: Where connections are made between new work and existing piping, make connection using suitable fittings for conditions encountered. Make each connection with existing pipe at time and under conditions with least interference with operation of existing pipeline and in compliance with local utility company.
G. Form and place concrete for thrust blocks or other specified methods of retainage at each change of direction or end of pipe main.
H. Place pipe to depth in accordance with Section 31 20 00.
I. Backfill trench in accordance with Section 31 20 00.
J. Install tracer wire continuous over top of non-metal pipe. Bury a minimum of 6 inches below finish grade, and above pipeline.
3.5 INSTALLATION - VALVES AND HYDRANTS
A. Install gate valves as indicated on Construction Drawings. Support valve on concrete pads with valve stem vertical and plumb. Install valve boxes in manner that will not transmit loads, stress, or shock to valve body. Center valve box over operating nut of valve vertical and plumb. Securely fit valve box together leaving cover flush with finished surface.
B. Install fire hydrant assemblies as indicated on Construction Drawings in vertical and plumb position with steamer/pumper nozzle pointed perpendicular to traffic where hydrant is adjacent to street, roadway, or parking lot drive or toward protected building unless otherwise directed by local authorities. Support hydrant assembly on concrete pad and firmly brace on side opposite inlet pipe against undisturbed soil and concrete blocking. Place minimum of 6-cubic feet of crushed stone or gravel around hydrant base and barrel after thrust blocking has cured at least 24 hours. Maintain vertical position of hydrant backfilling and compacting.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM
A. Disinfect distribution system with chlorine before acceptance for domestic operation. Chlorine dosage shall be not less than 50 parts per million. Flush lines before introduction of chlorinating materials and after contact period of not less than 24 hours. Flush with clean water after contact period until residual chlorine content is not greater than 1.0 part per million. Flush water dis- charged from water supply lines or hydrants shall not be allowed to discharge directly onto ex- posed soil or turf which could result in erosion of soil. If potential for erosion exists at discharge point, measures shall be taken to prevent erosion. Open and close valves in lines being disinfected several times during contact period. After disinfection, take water sample and bacteriological test in accordance with AWWA C651. Do not place distribution system in service until approval is obtained from local governing authorities.
B. Contractor shall provide a means of neutralizing the super-chlorinated water before releasing in- to the environment. This may be accomplished by either a method of dechlorinization or any method acceptable to federal, state, and local codes. Direct release to open ground shall not be allowed. Contractor shall not release super-chlorinated water directly into the sanitary sewer system, private or public, nor into any storm drain system.

3.7 SERVICE CONNECTIONS
A. Provide water service connection in compliance with utility company requirements including reduced pressure backflow preventer (if required) and water meter with by-pass valves and sand strainer. All tapping devices, backflow devices, detector check devices, meters, meter boxes and vaults shall be in accordance with local utility company details and specifications.

3.8 FIELD QUALITY CONTROL
A. Test water distribution system pipe installed below grade and outside building in accordance with the following procedures, unless otherwise directed by local jurisdiction:
1. Perform testing of pipe materials, joints, and other materials incorporated into construction of water mains and force mains to determine leakage and water tightness. Test pressure pipeline in accordance with Section 4 of AWWA C600 and NFPA 24. In the event state or local code requires more stringent test, more stringent test shall take precedence. When required by local jurisdiction, perform all tests in the presence of the utility company's representative.
2. Pressure Test: After pipe has been laid, subject newly laid pipe or valved section to hydrostatic pressure of at least 1.5 times working pressure at point of testing and not less than 1.25 times working pressure at highest point along test section.
3. Leakage Test: Conduct leakage test concurrently with pressure test. Leakage is defined as quantity of water that must be supplied into newly laid pipeline or valved section thereof to maintain pressure within 5 psi of specified test pressure after air in pipeline has been expelled and pipeline has been filled with water. Leakage shall not be measured by drop in pressure in test section over period of time. Leakage shall not be greater than that determined by the following formula:

\[ L = \frac{S \cdot D \cdot \sqrt{P}}{133,200} \]

Where: \( L \) = allowable leakage, (gallons per hour)
S = length of pipe tested, (feet)
D = nominal diameter of pipe, (inches)
P = average test pressure during test, (psig)

4. Visible Leakage: Repair visible leaks regardless of amount of leakage measured.
5. Acceptance of Installation: If test of pipe laid in place discloses leakage greater than that specified, Contractor shall, at his own expense, locate leak and make repairs as necessary until leakage is within specified allowance. Supply water for testing at no expense to Owner.

END SECTION
SECTION 33 31 00
SANITARY SEWER SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
1. Sanitary sewer drainage piping, fittings, accessories, cleanouts, and bedding.
2. Connection of site sanitary sewer system to municipal sanitary sewer systems.
B. Related Sections
1. Section 31 20 00 – Earthwork: Trenching, backfill, and compaction for utilities
2. Section 33 39 13 – Sanitary Utility Sewerage Manholes, Frames and Covers
3. Section 03 30 00 – Cast-in-place Concrete (in Architectural/Building Specifications)

1.2 REFERENCES
A. American Society for Testing and Materials (ASTM)
1. ASTM A 74 – Cast Iron Soil Pipe and Fittings
2. ASTM A 746 – Ductile Iron Gravity Sewer Pipe
3. ASTM C 425 – Compression Joints for Vitrified Clay Pipe and Fittings
4. ASTM C 564 – Rubber Gaskets for Cast Iron Soil Pipe and Fittings
5. ASTM C 700 – Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated
6. ASTM D 2241 – Poly (vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
7. ASTM D 2564 – Poly (Vinyl Chloride) (PVC) Solvent Cement
8. ASTM D 3034 – Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
9. ASTM F 477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe
B. American Water Works Association (AWWA)
1. AWWA C111 – Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings
2. AWWA C600 – Ductile-Iron Water Mains And Their Appurtenances
3. AWWA C900 – Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. Through 12 In, For Water Distribution

1.3 SUBMITTALS
A. Product Data: Provide data of pipe materials, pipe fittings, and accessories.
B. Manufacturer's Certificate: Certify that products meet or exceed specified or local requirements.
C. Project Record Documents:
1. Accurately record actual locations of pipe runs, connections, cleanouts, and invert elevations.
2. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.4 PROJECT CONDITIONS
A. Coordinate work with termination of sanitary sewer connection outside building and connection to municipal sewer utility service.

PART 2 - PRODUCTS

2.1 SEWER PIPE, FITTINGS, AND JOINTS
A. Polyvinyl Chloride Pipe (PVC): ASTM D 3034, rated SDR 35 for 6-inch and larger diameters, unless otherwise specified by the utility company (note that all public PVC sanitary sewer lines shall be SDR 26); ASTM D 3034, rated SDR 26 for 4-inch diameter. Pipe shall be continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification.
1. Pipe joints: Integrally molded bell ends, ASTM D 3034, Table 2, with factory supplied elastomeric gaskets and lubricant.

B. Ductile Iron Pipe (DIP): ASTM A 746, Class 50, inside nominal diameter as shown on the drawings, bell and spigot end. Permitted only when specified by local utility company.

2.2 PIPE ACCESSORIES
A. Pipe Joints: Mechanical clamp ring type, stainless steel expanding and contracting sleeve, neoprene-ribbed gasket for positive seal, unless otherwise directed by local jurisdiction.
B. Fittings: Same material as pipe molded or formed to suit pipe size and end design, in required tee, bends, elbows, cleanouts, reducers, traps, etc.

2.3 CLEANOUTS AND MANHOLES
A. Manholes shall conform to Section 33 39 13 unless otherwise specified by the utility company’s standard details and specifications.
B. Lid and Frame: Provide in accordance with Section 33 39 13. Provide traffic-rated covers and frames where cleanouts and manholes are in pavement, with the letters “SSCO” or “SANITARY SEWER”, respectively, cast into the cover, unless otherwise directed by local jurisdiction.
C. Shaft Construction: Cast iron shaft for cleanouts, of internal diameter as specified on Construction Drawings, with 2500 psi concrete collar.

2.4 APPURTENANCES
A. Tracer Wire: Magnetic detectable conductor (#12 copper), brightly colored plastic covering, imprinted with “Sanitary Sewer Service” in large letters.
B. Apron for Cleanout Covers: Where cleanouts are located in unpaved areas, provide minimum 24-inch square apron of 4-inch thick 2500 psi concrete flush with finished ground elevation.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Construction Drawings.

3.2 PREPARATION
A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
B. Remove large stones or other hard matter that could damage pipe or impede consistent backfilling or compaction.

3.3 TRENCHING AND BEDDING
A. Excavate trench and place bedding material in accordance with Section 31 20 00. Public sewer lines shall have bedding of such Class as specified by the local utility company.
B. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.

3.4 INSTALLATION – PIPE
A. Install type and class of pipe as shown on the drawings, unless otherwise directed by local jurisdiction. Pipes shall be laid and maintained to the required line and grade with necessary fittings, bends, manhole risers, cleanouts and other appurtenances placed at the required locations. The pipe shall be installed with uniform bearing under the full length of the barrel of the pipe. The pipe shall be inspected for defects and cracks before being lowered into the trench. Defective, damaged or unsound pipe, or pipe that has had its grade disturbed after laying, shall be taken up and replaced. Commence installation at lowest point with the bell end upgrade.
B. No pipe shall be laid in water or when trench conditions are unsuitable for work.
C. Pipe connecting to manholes or other structures shall terminate flush inside of structure wall.
D. Joints for PVC shall be thoroughly lubricated with an approved lubricant before pipe sections are slipped together. Open ends shall be fully protected with a stopper to prevent earth or other material from entering the pipe.
from entering the pipe during construction. Carefully free interior of the pipe from dirt, cement and other deleterious material as the work progresses.

E. Maintain separation of potable water main from sewer piping at crossings a minimum of 10 feet horizontal and 18 inches vertical.
F. Route pipe in straight line parallel to roads, buildings and adjacent utilities and as shown on the drawings.
G. Establish elevations of buried piping with sufficient cover as recommended by pipe manufacturer to ensure not less than 3 feet of cover, except as noted on drawings.
H. Form and place concrete for thrust blocks at each elbow of pipe force main. See construction drawing for details of construction.
I. Backfill trench in accordance with Section 31 20 00.
J. Install trace wire continuous over top of non-metal pipe. Bury 6 inches minimum below finish grade, above pipeline.

3.5 INSTALLATION – CLEANOUTS AND MANHOLES
A. Form bottom of excavation clean and smooth to correct elevation.
B. For cleanouts, form and place cast-in-place concrete base pad with provision for sanitary sewer pipe to be installed to proper elevations.
C. For manholes, construct inverters according to the following guidelines:
   1. Invert channel shall be smooth and accurately shaped to a semicircular bottom to match with the inside of the adjacent sewer section.
   2. Invert channels and structure bottoms shall be shaped with mortar and lean concrete.
   3. Changes in size and grade of invert shall be made gradually and evenly.
   4. Changes in the direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.
D. For manholes, provide manhole rings, frame, and cover as shown on the construction drawings, or as directed by local jurisdiction.

3.6 FIELD QUALITY CONTROL
A. Pipes and joints shall not be completely backfilled until after inspection, testing, and approval by the Owner and local jurisdiction.
B. Prior to testing for leakage, the pipe trench shall be backfilled to at least the spring line of the pipe. If required to prevent pipe movement during testing, additional backfill shall be added leaving the pipe joints uncovered to permit inspection.
C. Exfiltration Test
   1. Each section of sewer line between successive manholes shall be tested by closing the lower end of the sewer to be tested and the inlet sewer of the upper manhole, using stoppers.
   2. Fill the manhole and pipe with water to a point which produces a maximum of 3 feet of head above the invert of the sewer at the center of the upper manhole; or if groundwater is present, 3 feet of head above the average adjacent groundwater level.
   3. The allowable leakage shall be 200 gal/inch of pipe diameter/mile/day.
D. Infiltration Test
   1. If excessive ground water is encountered in the construction of a section of the sewer, the exfiltration test shall not be used.
   2. The upper and lower ends of the sewer to be tested shall be closed sufficiently to prevent the entrance of water.
   3. Pumping of ground water shall be discontinued for at least 3 days; then infiltration shall be tested.
   4. Infiltration into each section of sewer between adjoining manholes shall not exceed that allowed for the exfiltration test, except that head conditions shall be a maximum of 6 feet.
E. The Exfiltration Test may be limited to the manholes only when the authority having jurisdiction does not require the test and the construction manager waives the test. The Infiltration Test will always be required when excessive ground water is encountered in addition to the air test.
F. Air Test: Gravity systems shall be air tested between manholes at 3.5 psi for 5 minutes per ASTM F 1417 for plastic pipes.
G. Manholes shall be hydrostatic or vacuum-tested in accordance with the procedures outlined in TCEQ Chapter 217 regulations.
H. Deflection Test:
1. Deflection tests shall be conducted on all plastic pipe using a mandrel with a diameter equal to 95 percent of the inside diameter of the pipe. The test shall be performed without mechanical pulling devices.
2. Allowable Deflection: Maximum allowable pipe deflection shall not exceed 5 percent of nominal inside diameter.
3. Mandrel: Mandrel, go/no-go, device shall be cylindrical in shape and constructed with either 9 or 16 evenly spaced arms or prongs. Mandrels with fewer arms will be rejected as not sufficiently accurate. Contact length of mandrel's arms shall equal or exceed nominal inside diameter of sewer to be inspected. Critical mandrel dimensions shall carry tolerance of 0.01-inch maximum. Contractor shall provide mandrel and necessary equipment for mandrel test.
4. Procedure: Mandrel shall be hand-pulled through flexible pipe sewer lines no earlier than 30 days after trench has been completely backfilled. Sections of sewer not passing mandrel shall be uncovered and re-bedded, re-rounded, or replaced to satisfaction of Owner or governing agency. Repaired section shall be retested.

I. Provide measuring devices, meters, water, materials, and labor for making the required tests.
J. Tests shall be conducted in the presence of the Owner’s representative and, when required by local jurisdiction, in the presence of the utility company’s representative. Test data shall be submitted to the Engineer for review and approval.

END OF SECTION
SECTION 33 39 13
SANITARY SEWER MANHOLES

PART 1 – GENERAL

1.1 SUMMARY
A. Section Includes
1. Monolithic concrete, modular precast concrete, masonry, and precast polyethylene manhole assemblies.
B. Related Sections
1. Section 31 20 00 – Earthwork: Excavation, backfill, and compaction
2. Section 33 31 00 – Sanitary Sewer Systems
3. Section 33 40 00 – Storm Drainage Utilities
4. Section 03 30 00 – Cast-In-Place Concrete (see Architectural/Building specifications)

1.2 REFERENCES
A. American Society for Testing and Materials (ASTM)
   1. ASTM A 48 – Gray Iron Castings
   2. ASTM C 270 – Mortar for Unit Masonry
   3. ASTM C 443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
   4. ASTM C 478 – Precast Reinforced Concrete Manhole Sections
   5. ASTM C 923 – Resilient Connectors Between Reinforced Concrete Manhole Structures and Pipes
   6. ASTM D 1248 – Polyethylene Plastics Molding and Extrusion Materials
   7. ASTM D 2412 – Determination of External Loading Characteristics of Plastic Pipe
B. American Association of State Highway and Transportation Officials (AASHTO)
   1. AASHTO M 306 – Drainage, Sewer, Utility and Related Castings.
C. International Masonry Industry All-Weather Council (IMIAC)
D. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or on the Construction Drawings) to various item (or section) numbers from State DOT specifications are for purposes of additional information only; where conflicts may exist, the project specifications herein shall supersede the referenced State DOT specs. General requirements of the State DOT specifications as related to bid award, contract execution, scope of work, measurement and payment shall not be binding on this project unless otherwise specified in writing.

1.3 SUBMITTALS
A. Shop Drawings: Indicate reference to Construction Drawings of manhole locations, elevations, piping with sizes, locations, and elevations of penetrations.
B. Product Data: Provide data for manhole covers, component construction, features, configuration, and dimensions.

PART 2 - PRODUCTS

2.1 MANHOLES
A. Cast-In-Place Concrete: Non-reinforced cast in place concrete barrel.
   1. Concrete: 3500 psi concrete conforming to Section 03 30 00.
   2. Forms: Steel sheet accurately shaped and fabricated of sufficient strength to form dense watertight walls to true dimensions.
   3. Pipe connections shall be watertight, size-on-size resilient connectors that allow for differential settlement and conform to ASTM C-923.
B. Precast Concrete: Reinforced precast concrete barrel.
   1. Manhole sections conforming to ASTM C 478 with joint gaskets conforming to ASTM C443.
   2. Construct manholes of precast concrete sections as required by Construction Drawings to size, shape, and depth indicated.
3. Sewer pipe boot gaskets shall be watertight, size-on-size resilient connectors that allow for differential settlement and conform to ASTM C 923.

C. Precast Polyethylene (only if permitted by local jurisdiction):
   1. Manufacturer: Advanced Drainage Systems (ADS) or approved equal.
   2. Precast polyethylene in accordance with ASTM D 1248. Nominal cylinder internal diameter shall be 48-inches and shall be designed to accept concrete filled polyethylene manhole lids and standard cast iron frames with lid or grate.
   3. Manholes shall have compressive strength that meets ASTM D 2412 standards.

D. Mortar and Grout: Mortar for finishing and sealing shall be Type S in accordance with ASTM C270. Honeycombing less than 2-inches deep shall be repaired using Type O mortar in accordance with ASTM C 270.

E. Configuration:
   1. Barrel Construction: Concentric with eccentric cone top section.
   2. Shape: Cylindrical
   3. Clear Inside Dimensions: 48-inches diameter, minimum, unless larger diameter is indicated on Construction Drawings.
   4. Design Depth: As indicated on Construction Drawings.
   5. Clear Lid Opening: 30-inches minimum
   6. Pipe Entry: Provide openings as indicated on Construction Drawings
   7. Main and Lateral Pipes: Neatly cut off main and lateral pipes flush with inside of manhole or inlet where they enter structure walls. Point-up irregularities and rough edges with non-shrinking grout.
   8. Interior steps or rungs are not permitted per TAC30 Chapter 217 TCEQ regulations

F. Inverts: Shape inverts across structure floor to form a U-shaped channel at uniform grade between pipe inverts. Use concrete and mortar to obtain proper grade and contour. Finish surface with fine textured wood float. Size of inverts shall be per TAC30 Chapter 217 TCEQ regulations, as follows:
   1. A manhole connected to a pipe less than 15-in. diameter must have a channel depth equal to at least half the largest pipe's diameter.
   2. A manhole connected to a pipe at least 15-in. diameter but not more than 24-in. diameter must have a channel depth equal to at least three-fourths of the largest pipe's diameter.
   3. A manhole connected to a pipe greater than 24-in. diameter must have a channel depth equal to at least the largest pipe's diameter.

2.2 COMPONENTS
   A. Lid and Frame:
      2. ASTM A 48, Class 30B heavy duty cast iron construction, machined flat bearing surface. For manholes constructed in paved areas and subject to traffic loading, lid and frame shall also conform to AASHTO M 306.
      3. Removable lid, closed or open as indicated on Construction Drawings, sealing gasket.

PART 3 – EXECUTION

3.1 EXAMINATION
   A. Verify items specified by other Sections are properly sized and located.
   B. Verify that built-in items are in proper location and ready for roughing into work.

   Verify that the excavation for manholes is correct.

3.2 PREPARATION
   A. Coordinate placement of inlet and outlet pipe or duct sleeves per Construction Drawings.

3.3 PRECAST MANHOLE CONSTRUCTION
   A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
   B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
1. After completion of slab foundation, lower first joint of manhole barrel into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert. Pour invert immediately after setting of first section of manhole barrel.  
2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer's recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.  
C. Set cover frames and lids level without tipping, to correct elevations. Utilize pre-cast rings to achieve final rim elevation. Maximum limit, 4 rings.

3.4 CAST-IN-PLACE MANHOLE CONSTRUCTION  
A. Cast-in-place concrete shall conform to the applicable requirements of Section 03 30 00 and local utility company. Utilize steel forms.  
B. Place base pad to proper elevation and location and pour monolithically with invert.  
C. Deposit concrete in evenly distributed layers of about 18 inches, with each layer vibrated to bond to preceding layer.  
D. Place gasket between all joints and paint exterior within 5' of joints with mastic waterproofing.  
E. Place precast concrete cone.  
F. Set section cover frames and lids level without tipping, to correct elevations. Utilize pre-cast rings to achieve final rim elevation. Maximum limit, 4 rings.

END OF SECTION
SECTION 33 40 00
STORM DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY
A. Section Includes
1. Storm sewer drainage piping, fittings, and accessories.
2. Storm drainage structures.
B. Related Requirements
1. Section 31 20 00 – Earthwork: Excavation, trenching, backfill, and compaction.
2. Section 31 25 00 – Erosion and Sedimentation Controls
3. Section 33 39 13 – Sanitary Sewer Manholes
4. Section 03 30 00 – Cast-In-Place Concrete: (see Architectural / Building specifications)
5. Stormwater Pollution Prevention Plan (SWPPP)

1.2 REFERENCES
A. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO M252 – Corrugated Polyethylene Drainage Tubing, 3 to 10 Inch Diameter
2. AASHTO M294 – Corrugated Polyethylene Drainage Tubing, 12 to 48 Inch Diameter
3. AASHTO MP7-97 – Corrugated Polyethylene Drainage Tubing, 54 to 60 Inch Diameter
4. AASHTO M198 – Joints for Circular Sewer and Culvert Pipe Using Flexible Watertight Gaskets
5. AASHTO H170 – Reinforced Concrete Culvert, Storm Drain and Sewer Pipe
B. American Society for Testing and Materials (ASTM)
1. ASTM A 185 – Steel welded Wire Fabric, Plain, for Concrete Reinforcement
2. ASTM A 615 – Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
3. ASTM C 76 – Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
4. ASTM C 150 – Portland Cement
5. ASTM C 206 – Finished Hydrated Lime
6. ASTM C 443 – Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets
7. ASTM C 478 – Precast Reinforced Concrete Manhole Sections
8. ASTM C 564 – Rubber Gasket for Cast Iron Soil Pipe and Fittings
9. ASTM C 969 – Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe
   Sewer Lines
10. ASTM C 1433 – Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm
    Drains and Sewers
11. ASTM D 3034 – Type PSM Polyvinyl Chloride (PVC) Sewer Pipe and Fittings
13. ASTM F 477 – Elastomeric Seals (Gaskets) for Joining Plastic Pipe
14. ASTM F 949 – Poly (Vinyl Chloride)(PVC) Corrugated Sewer Pipe with Smooth Interior and
    Fittings
15. ASTM F 2306 – 12 to 60 inch Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and
    Fittings for Gravity-Flow Storm Sewer and Subsurface Drainage Applications
16. ASTM F 2648 – 2 to 60 inch Annular Corrugated Profile-Wall Polyethylene (PE) Pipe and Fittings for
    Land Drainage Applications
C. American Concrete Institute (ACI)
1. ACI301 – Structural Concrete for Buildings
D. Texas Department of Transportation (TxDOT) – Standard Specifications for Construction and
   Maintenance of Highways, Streets and Bridges (2004). References within these specifications (and/or
   on the Construction Drawings) to various item (or section) numbers from State DOT specifications are
   for purposes of additional information only. Where conflicts may exist, the project specifications herein
   shall supersede the referenced State DOT specs. General requirements of the State DOT
   specifications as related to bid award, contract execution, scope of work, measurement and payment
   shall not be binding on this project unless otherwise specified in writing.

1.3 SUBMITTALS
Aqueous Engineering

Page 1 of 4

17.077

33 40 00

STORM DRAINAGE
A. Product Data: Provide data on pipe materials, pipe fittings, and accessories. Provide shop drawings for precast inlets, catch basins and junction boxes.
B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.
C. Project Record Documents
   1. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
   2. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

1.4 PROJECT CONDITIONS
A. Coordinate work with termination of storm sewer connection outside building including connection to municipal storm sewer system.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS
A. Reinforced Concrete Pipe (RCP): ASTM C 76, Class III unless noted otherwise on Drawings, installed with flexible plastic, bitumen gaskets at joints.
   1. Gaskets: AASHTO M198 751, Type B or ASTM C 443, installed in accordance with manufacturer's recommendations. Pipes located under or within 5 feet (horizontally) of any building foundation shall have water-tight gaskets.
   2. Flared end sections shall be per ASTM C 76 or AASHTO H170 (for sections with toe wall)
B. High Density Polyethylene Pipe (HDPE): AASHTO Designation M252 Type S, M294 Type S and MP7-97 Type S, or ASTM F 2648, smooth interior/annular exterior. Permitted unless specifically excluded on Drawings or by local jurisdiction. Pipe shall be installed in accordance with pipe manufacturer's installation Guidelines for Culvert Storm Drainage Applications.
   1. Pipe Joints and fittings shall conform to AASHTO M252 and M294, or ASTM F 2648 and F 2306. Pipes located under or within 5 feet (horizontally) of any building foundation shall have manufacturer's standard water-tight fittings. Unless noted otherwise on the Drawings, pipes located greater than 5 feet from any building foundation are required to have manufacturer's standard soil-tight fittings only.
C. Polyvinyl Chloride (PVC) Pipe: ASTM D 3034, rated SDR 35 (or ASTM F 949 for Profile Pipe) continually marked with manufacturer's name, pipe size, cell classification, SDR rating, and ASTM D 3034 classification. Only permitted for pipe diameters 12-inches or smaller, when specifically indicated on Drawings and if allowed by local jurisdiction.
   1. Pipe joints: ASTM D 3212 using restrained gasket conforming to ASTM F 477. Pipes located under or within 5 feet (horizontally) of any building foundation shall have manufacturer's standard water-tight fittings. Unless noted otherwise on the Drawings, pipes located greater than 5 feet from any building foundation are required to have manufacturer's standard soil-tight fittings only.
D. Subdrains: Perforated, PVC or flexible corrugated plastic pipe, as specified herein, of the size indicated on the drawings.

2.2 DRAINAGE STRUCTURES
A. Manholes: Conform to Section 33 39 13.
B. Grates and Frame: Provide in accordance with details shown on Drawings.
   1. Provide heavy duty grates, with maximum slot width of 1-1/8” in all areas subject to vehicle or pedestrian traffic, or maximum slot width of 1-1/2” in all other areas.
   2. Acceptable Manufacturers:
      a. Neenah Foundry.
C. Cast-In-Place concrete for drainage structures, including manholes, inlets, catch basins, junction boxes, collars, support blocks, headwalls and paved ditches, shall conform to ACI 301. In- let, catch basin and junction box construction shall conform to ASTM C 478.
1. Compressive Strength: 3500 psi at 28 days, unless noted otherwise on Drawings.
2. Reinforcement: ASTM A 615, grade 40 or 60 deformed reinforcing bars, and ASTM A 185 for wire fabric.
3. Precast concrete drainage structures, including box culvert sections, headwalls, manholes, in-lets, catch basins and junction boxes: construction shall conform to ASTM C 478 and C 1433.
4. Cement Mortar used for paving inverts, filling lift holes, joints, patching and anchoring castings shall consist of one part Portland cement, type I, ASTM C 150, 1/4 part hydrated lime, ASTM C 206 and 2-1/2 parts clean, well-graded sand and water free of suspended matter, alkali, and containing no industrial or domestic waste.

PART 3 - EXECUTION

3.1 EXAMINATION
A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Drawings.

3.2 PREPARATION
A. Hand trim excavations to required elevations. Correct over excavation with bedding material.
B. Remove large stones or other hard matter that could damage piping or impede consistent back-filling or compaction.
C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and re-placed, as necessary, by same.

3.3 INSTALLATION – PIPE
A. The pipe shall be inspected for defects and cracks before being lowered into the trench, piece by piece. Any defective, damaged or unsound pipe, or any pipe that has had its grade disturbed after laying, shall be taken up and replaced. Open ends shall be protected with a stop-er to prevent earth or other material from entering the pipe during construction. The interior of the pipe shall be free from dirt, excess water and other foreign materials as the pipe laying progresses and left clean at the completion of the installation.
B. Excavate pipe trench and place bedding material in accordance with Section 31 20 00.
C. Trench excavation sidewalls shall be sloped, shored, sheeted, braced, or otherwise supported by means of sufficient strength to protect workmen in accordance with applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.
D. Installation shall commence at the lowest point for each segment of the route. RCP shall be laid with the groove or bell end upstream.
E. Lay pipe to the required line and slope gradients with the necessary fittings, bends, manhole, risers and other appurtenances placed at the required location as noted on Drawings.
F. Do not displace or damage pipe when compacting.
G. No pipe shall be laid in water or when trench conditions are unsuitable for such work.
H. Joints:
   1. Joints shall be constructed as described herein and in accordance with manufacturer’s installation instructions with the intent that they be made watertight.
   2. For RCP, the joint surface shall be cleaned and washed with water, if necessary, before the joints are made. Use gaskets as specified herein. In all pipes 36” diameter or larger, annular space between pipe sections shall be completely filled with mortar and finished off smooth with the inside surface of the pipe, unless all joints are inspected and approved by Engineer or Owner’s representative prior to backfilling.
   3. PVC fittings shall be attached to the pipe by solvent welding according to the manufacturer’s recommendations.

3.4 INSTALLATION – MANHOLES, CATCH BASINS, INLETS, AND JUNCTION BOXES
A. Drainage structures shall be constructed in accordance with details shown on Drawings (or per TxDOT Standard Details), and in accordance with Section 33 39 13 as applicable.

B. Precast Sections:
1. Precast section with bases shall be installed in accordance with Section 31 20 00 and 33 39 13 or as shown on drawings.
2. Pipe openings shall be aligned to that of the pipe entering and leaving the manhole, etc. Pipe shall be properly aligned with connections to manholes, etc. as shown on the drawings.

C. Cast-In-Place sections shall be as shown on the drawings in accordance with Section 03 30 00.
1. Form bottom of excavation clean and smooth to correct elevation.
2. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.
3. Form and place cast-in-place concrete walls, sleeved at proper elevation to receive storm sewer pipe in accordance with details shown on Drawings.

D. Invert channels shall be smooth and accurately shaped to a semicircular bottom conforming to the inside of the adjacent sewer section. Invert channels and structure bottoms shall be shaped with cement mortar. Changes in size and grade of invert shall be made gradually and evenly. Changes in direction of the sewer entering branch or branches shall have a true curve of as large a radius as the manhole will permit.

E. Frames and Covers:
1. Frames and covers shall be set to the proper elevation. The frames shall be firmly embedded in mortar approximately 1 inch thick and aligned to fit the top section of the structure.
2. Bricks set in mortar used to adjust the frame to finished grade shall be limited to no more than four courses.
3. Adjustment rings used to make adjustments in grade shall be made with the initial ring embedded in mortar and the exterior of the rings parged with mortar not less than 1/2 inch thick. No adjustment made in this manner shall exceed 8 inches.

F. Concrete cradles shall be constructed as shown on the drawings and as needed when crossing over and under sewers pipe or utility lines. Concrete shall be 3000 psi mix with a minimum thickness of 6 inches.

3.5 SUBDRAINS
A. Subdrains shall be installed in accordance with the details and at the locations shown on the drawings. Refer to MEP drawings for foundation drains.

3.6 INSPECTION AND TESTING
A. General
1. Storm sewer systems and culverts, upon completion or at such time as directed, shall be cleaned, inspected and tested. The system or culvert shall have a true grade and line. Actual elevations shall be within 0.05 feet of the elevations given on the drawings.
2. After completion of the Work, or any part thereof, the job shall be tested to determine that it has been installed in accordance with the drawings and specifications. In general, the Work shall prove to be in good condition, installed in accordance with the drawings and specifications and ready for use.

B. Cleaning and Testing
1. Visibly inspect and remove all debris and obstructions from storm pipe. Manholes and pipe shall conform to ASTM C 969 leakage criteria.

C. Alignment Test
1. After backfill has been placed and compacted to a depth not less than one foot above top of pipe, a visual inspection shall be made by flashing a light between manholes. Any dis-placement or misalignment of invert shall be corrected.

END OF SECTION