Devil’s River SNA - Dan A. Hughes Unit
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PROJECT MANUAL
VOLUME 2 OF 2
DIVISIONS 23-33

APRIL 16, 2021
TPWD PROJECT NO. 118540
BRW PROJECT NO. 217067.00

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PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Transition fittings.
   3. Dielectric fittings.
   4. Mechanical sleeve seals.
   5. Sleeves.
   7. Grout.
   8. Equipment installation requirements common to equipment sections.
   10. Supports and anchorages.

1.02 RELATED DOCUMENTS

A. Required construction codes listed in drawings.

B. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230529 Hangers and Supports for HVAC Piping and Equipment.

B. Section 238126 Split System Air conditioners.

C. Section 089000 Louvers and Vents.

1.04 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, 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 chases.

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.

F. The following are industry abbreviations for plastic materials:
   1. CPVC: Chlorinated polyvinyl chloride plastic.
   2. PE: Polyethylene plastic.
   3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.05 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Shop Drawings: Shop drawings for HVAC systems including the following component. Refer to section 233113 Metal Ducts for specifics regarding ductwork systems.
   1. Provide shop drawings for each location required for multiple piping supports and trapeze hangers. Provide manufacturer’s catalog data including load capacity.
   2. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   4. Detail removable insulation at piping specialties, equipment connections, and access panels.
   5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.
7. Detail field application for each equipment type.
8. Special fittings.
10. Motorized-control damper installations.

1.06 QUALITY ASSURANCE

A. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is on the “Alternate Manufacturer Evaluation Form”, subsequently approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

B. Contractor shall be licensed by TDLR.

1.07 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 to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.08 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Section "Access Doors and Frames."

1.09 AS-BUILT DRAWINGS

A. Definitions
1. Contractor Markups – Drawings that are marked and annotated to show the project As-Built and constructed by the contractor. They are part of the working as-built set.

2. As-Built Drawings – The amended “As-designed” drawing revised to show the project as the contractor built and constructed it. The revisions from Contractor Markups and field inspection notes are transferred to the Final as-built set of drawings. The final as-built drawings include modifications during construction, field requested changes, shop drawing modifications, and contractor designs.

B. Description Of Work
1. Section includes: Administrative and procedural requirements for as-built process for contractor to follow.

C. Record Document Submittals
1. Record As-Built Drawings: General Contractor shall maintain on-site 2 sets of as-built Contract Drawings, in Contractor Field Office. Working as-built drawings shall be kept current on a weekly basis and at least one paper set of as-built drawings shall be available on the jobsite at all times.
   a. Changes to Drawings, including those that involve only narrative, shall be clearly and neatly marked in red pen or pencil, and shall be noted on appropriate drawings. Changes to the Contract Drawings include:
   b. 
      1. Changes to material or equipment for substitutions approved through the Architect/Engineer’s submittal process.
      2. Where contract drawings or specifications show options or alternates, only the option selected for construction shall be shown on the final as-built prints. Cross out such words and phrases as “approved equal” and list specifically the material provided. This shall include actual make and model number of equipment installed, as well as voltage and MCA.
      4. RFIs and Change Order information.
      5. Changes made by the Inspector to accommodate field conditions.
      6. Actual location, kinds and sizes of all existing and new utility lines, especially underground lines within the construction area. Measurements shall be shown for all change of direction points and all surface or underground components such as valves, manholes, drop inlets, clean outs, meters, etc.
      7. Changes in location of equipment and architectural features.
      8. Systems designed or enhanced by the Contractor, such as HVAC controls, fire alarm, and irrigation systems.
      9. All construction changes that result from the final inspection.
c. General Contractor shall note each entry with a notation referencing source of information (Example: RFI #94, CO #3, or field notes of same).
   1. As-built record drawings shall be updated no less frequently than once per week.
   2. Verification of current as-built record drawing status is included in the monthly payment approval process that shall be noted in the inspector’s log notes.
   3. Individual(s) responsible for the verification of the as-built process shall be identified to the Architect/Engineer.

d. When completed, scanned pdf copies of the as-built drawings shall be sent to the Owner and Architect/Engineer for final approval. Compliance and delivery of the final as-built drawings will be enforced through the approval of progress payments. The quality of the final as-built drawings will be reflected in the construction contractor’s performance evaluation.

D. Mark-Up Guideline

The following information is provided to improve the quality of the marked-up prints and thereby facilitate preparation of final as-built drawings. The most important guideline is that the marked-up changes on the prints shall be complete and understandable.

1. Frequently use written explanation on As-Built drawings to describe changes. Do not rely totally on graphic means to convey the revision.

2. Legibility of lettering and digit values shall be clean and clear and readable from a scanned copy.

3. Whenever a revision is made, make changes to affect related section views, details, legend, plans and elevation view, schedules, notes and call-out designations, and mark accordingly to avoid conflicting data on all other sheets.

4. When changes are required on small-scale drawings or on drawings with limited area available, large-scale inserts shall be drawn or sketched, with leaders to the location where applicable.

5. When attached prints (or sketches) are provided with marked-up print, indicate whether:
   a. Entire drawing shall be added to contract drawings or
   b. Whether the contract drawings shall be changed to agree, or
   c. For reference only to further details not required for initial design.

6. Make the comments on the drawing complete without reference to letters, memo’s or materials that are not also a part of the As-Built. For instance, do not just say, “As per Change Order #12”, when the actual change order states, “Changed water pipe from 2-1/2” to 3”. This also applies for changes as per the Architect/Engineer, Owner or Inspector.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.02 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.03 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. 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.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Solvent Cements for Joining Plastic Piping:
   1. CPVC Piping: ASTM F 493.
2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

H. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.04 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
      e. Smith-Blair, Inc.
      f. Viking Johnson.
   2. Underground Piping NPS 1-1/2 and Smaller: Manufactured fitting or coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

B. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
   1. Manufacturers:
      b. Fernco, Inc.
      d. Plastic Oddities, Inc.

2.05 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig minimum working pressure at 180 deg F.
   1. Available Manufacturers:
      a. Capitol Manufacturing Co.
      c. Zurn Industries, Inc.; Wilkins Div.
D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
   1. Available Manufacturers:
      a. Capitol Manufacturing Co.
      b. Epco Sales, Inc.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Central Plastics Company.
      c. Pipeline Seal and Insulator, Inc.
   2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig minimum working pressure at 225 deg F.
   1. Available Manufacturers:
      a. Calpico, Inc.
      b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig minimum working pressure at 225 deg F.
   1. Available Manufacturers:
      a. Perfection Corp.
      b. Precision Plumbing Products, Inc.
      c. Victaulic Co. of America.

2.06 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Available Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Metraflex Co.
      c. Pipeline Seal and Insulator, Inc.
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Carbon steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.
2.07 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.08 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. Split-Casting, Deep pattern: With concealed hinge, set screw or spring clips, and chrome-plated finish.

C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

D. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw or spring clips, and chrome-plated finish.

E. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.09 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Install piping to allow application of insulation.

J. Select system components with pressure rating equal to or greater than system operating pressure.

K. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: Split-case, deep-pattern type.
      b. Chrome-Plated Piping: Split case, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: Split-case, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split case, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-case, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Unfinished Service Spaces: Split-case, stamped-steel type with exposed-rivet hinge and set screw.
      h. Bare Piping in Equipment Rooms: Split-case, stamped-steel type with set screw or spring clips.
      i. Bare Piping at Floor Penetrations in Equipment Rooms: Split-case, floor-plate type.

L. Install sleeves for pipes passing through concrete and masonry walls, 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. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are 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 NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions.
   c. 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. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

M. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
   1. Install steel pipe for sleeves smaller than 6 inches in diameter.
   2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
   3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

N. Verify final equipment locations for roughing-in.

O. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.02 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### 3.03 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

### 3.04 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

### 3.05 PAINTING

A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
3.06 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project. Coordinate with Structural Engineer.
   1. Construct concrete bases shall be at least 3” larger than mounted equipment on all sides.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 033000 Section "Cast-in-Place Concrete”.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

3.08 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
   B. Clean surfaces that will come into contact with grout.
   C. Provide forms as required for placement of grout.
   D. Avoid air entrapment during placement of grout.
   E. Place grout, completely filling equipment bases.
   F. Place grout on concrete bases and provide smooth bearing surface for equipment.
   G. Place grout around anchors.
   H. Cure placed grout.

END OF SECTION 23 05 00
SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIP.

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following hangers and supports for HVAC 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.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230500 Common Work Results For HVAC.

B. Section 238126 Split System Air conditioners.

1.04 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."

1.05 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.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
2. Fiberglass pipe hangers.
3. Thermal-hanger shield inserts.
4. Powder-actuated fastener systems.

PART 2 - PRODUCTS

2.01 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. Available Manufacturers:
   1. AAA Technology & Specialties Co., Inc.
   2. B-Line Systems, Inc.; a division of Cooper Industries.
   3. Carpenter & Paterson, Inc.
   4. ERICO/Michigan Hanger Co.
   5. Grinnell Corp.
   7. PHS Industries, Inc.

C. Galvanized, Metallic Coatings: Pre-galvanized or hot dipped.

D. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.02 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.

2.03 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Available Manufacturers:
   2. Grinnell Corp.; Power-Strut Unit.
   3. National Pipe Hanger Corp.
   4. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
D. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

2.04 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Available Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.

C. Material for Cold Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate with vapor barrier.

D. Material for Hot Piping: ASTM C 552, Type I cellular glass or water-repellent-treated, ASTM C 533, Type I calcium silicate.

E. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.

F. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield. FASTENER SYSTEMS

2.05 POWDER-ACTUATED FASTENERS

A. Description: 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. Note that written permission must be obtained from Architect, Owner or Structural Engineer if this method is used on structural members.
   1. Available Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

2.06 MECHANICAL-EXPANSION ANCHORS

A. Description: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Note that written permission must be obtained from Architect, Owner or Structural Engineer if this method is used on structural members
   1. Available Manufacturers:
b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

2.07 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.08 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 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 pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
4. Adjustable Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary
6. pipes, NPS 1/2 to NPS 8.
7. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
8. U-Bolts (MSS Type 24): For support of heavy pipe, NPS 1/2 to NPS 30.
9. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange.
10. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36, with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
11. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-Type support for pipes, NPS 2-1/2 to NPS 36, if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
12. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
13. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20, from single rod if horizontal movement caused by expansion and contraction might occur.
14. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42, if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
15. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24, if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
16. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30, 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.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, 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 for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 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 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. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
8. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
9. 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.
   b. Medium (MSS Type 32): 1500 lb.
   c. Heavy (MSS Type 33): 3000 lb.
10. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

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 by manufacturer to prevent crushing insulation.
3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high density, 100-psi minimum compressive-strength, water-repellant-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
2. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.

3.02 HANGER AND SUPPORT INSTALLATION

A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
B. Channel Support System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled channel systems.
   1. Field assemble and install according to manufacturer's written instructions.

C. Heavy-Duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated, heavy-duty trapezes.
   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 D-1.1.

D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

F. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.


I. 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.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.

K. 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 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.

L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

M. 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.

N. 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 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 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: 12 inches long and 0.048 inch thick.
   b. NPS 4: 12 inches long and 0.06 inch thick.
   c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
   d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
   e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.

5. Pipes NPS 8 and Larger: Include wood inserts.

6. Insert Material: Length at least as long as protective shield.

7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.03 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.04 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.

3.05 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.

3.06 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.

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 09 painting Sections or Section "High-Performance Coatings."

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 23 05 29
SECTION 23 05 53 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Equipment nameplates.
   2. Equipment markers.
   3. Access panel and door markers.
   4. Pipe markers.
   5. Stencils.
   6. Warning tags.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 238126 Split System Air conditioners.
B. Section 233423 HVAC Power Ventilators.
C. Section 238239 Unit Heaters.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
1.05 QUALITY ASSURANCE


1.06 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 locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 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.
   2. Location: Accessible and visible.
   3. Fasteners: As required to mount on equipment.

B. Equipment Markers: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2. Fabricate in sizes required for message
   1. Terminology: Match schedules as closely as possible.
   2. Data:
      a. Name and plan number.
      b. Equipment service.
      c. Design capacity.
      d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.
   3. Size: 2-1/2 by 4 inches for control devices, dampers, etc; 4-1/2 by 6 inches for equipment.

C. 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.

2.02 PIPE IDENTIFICATION DEVICES

D. Manufactured Pipe Markers, General: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
   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. Pipes with OD, Including Insulation, 6 Inches and Larger: Either full-band or strip-type pipe markers at least three times letter height and of length required for label.
   5. Arrows: Integral with piping system service lettering to accommodate both directions; or as separate unit on each pipe marker to indicate direction of flow.

E. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

2.03 STENCILS

F. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door markers, equipment markers, equipment signs, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, alkyd enamel or acrylic enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel or acrylic enamel in colors according to ASME A13.1 unless otherwise indicated.

2.04 WARNING TAGS

G. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: 3 by 5-1/4 inches minimum.
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
2.05 PIPE LABELS: Note that pipe labels shall follow the Pipe Label Schedule below.

H. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

I. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive. For indoor insulated piping greater than 6” Insulation OD, labels may be secured with plastic zip ties. For similar outdoor piping a metal strap or cable can be used.

Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings and on schedule below.

<table>
<thead>
<tr>
<th>SERVICE</th>
<th>MARK</th>
<th>LETTERING COLOR</th>
<th>BACKGROUND COLOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refrigerant Line set</td>
<td>REFGN – FCU-X</td>
<td>WHITE</td>
<td>GREEN</td>
</tr>
<tr>
<td>Condensate Drain-Gravity</td>
<td>CD</td>
<td>WHITE</td>
<td>GREEN</td>
</tr>
<tr>
<td>X IS THE FCU Mark</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PART 3 - EXECUTION

3.01 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. Split system units (fan coil units and condensing units).
   3. Unit heaters.
B. Install equipment markers with mechanical fasteners on or near each major item of mechanical equipment. Data required for markers may be included on signs, and markers may be omitted if both are indicated.
   1. 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.
   2. Data: Distinguish among multiple units, indicate operational requirements, indicate safety and emergency precautions, warn of hazards and improper operations, and identify units.
   3. Locate markers where accessible and visible. Include markers for the following general categories of equipment:
      a. Fans.
      b. Split system units (fan coil units and condensing units).
      c. Unit heaters.

C. Stenciled Equipment Marker Option: Stenciled markers may be provided instead of laminated plastic equipment markers, at Installer's option, if lettering larger than 1 inch high is needed for proper identification because of distance from normal location of required identification.

D. Install access panel markers with screws on equipment access panels.

3.02 PIPE IDENTIFICATION

A. Install manufactured pipe markers indicating service on each piping system.
   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, 6 Inches and Larger: Shaped pipe markers. Use size to match pipe and secure with fasteners.

B. Stenciled Pipe Marker Option: Stenciled markers may be provided instead of manufactured pipe markers, at Installer's option. Install stenciled pipe markers with painted, color-coded bands or rectangles complying with ASME A13.1 on each piping system.
   1. Identification Paint: Use for contrasting background.

C. 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 penetrations through walls, floors, ceilings, and non-accessible enclosures.
   2. At access doors, manholes, and similar access points that permit view of concealed piping.
   3. Near major equipment items and other points of origination and termination.
4. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
5. On piping above removable acoustical ceilings. Omit immediately spaced markers.

3.03 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

3.04 ADJUSTING

A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

3.05 CLEANING

A. Clean faces of mechanical identification devices.

END OF SECTION 23 05 53
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 SUMMARY
   A. This Section includes TAB to produce design objectives for the following:
      1. Air Systems:
         a. Constant-air-volume 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.
      5. Duct leakage tests.
      6. Control system verification.

1.02 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS
   A. Section 233300 Air Duct Accessories.
   B. Section 238126 Split System Air conditioners.
   C. Section 233423 HVAC Power Ventilators.

1.04 DEFINITIONS
   B. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
   C. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.
   D. 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.
   E. BAS: Building automation system.
F. 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.

G. NC: Noise criteria.


I. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

J. RC: Room criteria.

K. Report Forms: Test data sheets for recording test data in logical order.

L. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

M. 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.

N. TAB: Testing, adjusting, and balancing.

O. TABB: Testing, adjusting, and balancing bureau.

P. TDH: Total dynamic head.

Q. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

R. Test: A procedure to determine quantitative performance of systems or equipment.

S. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.05 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 2 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.


D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.06 QUALITY ASSURANCE

A. TAB Specialists Qualifications: Certified by AABC, NEBB, or TABB.
   1. TAB Field Supervisor: Employee of the TAB specialist and certified by AABC, NEBB, or TABB.
   2. TAB Technician: Employee of the TAB specialist and certified by AABC, NEBB, or TABB.

B. Instrumentation Type, Quantity, Accuracy, and Calibration: Comply with requirements in ASHRAE 111, Section 4, "Instrumentation."

C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6.7.2.3 - "System Balancing."

D. TAB Conference: Meet with Owner's and Architect's representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items: Include at least the following:
      a. Submittal distribution requirements.
      c. TAB plan.
      d. Work schedule and Project-site access requirements.
      e. Coordination and cooperation of trades and subcontractors.
      f. Coordination of documentation and communication flow.

E. 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.

G. Instrumentation Type, Quantity, and Accuracy: As described in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems".

H. 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.

1.07 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 and water distribution systems have been satisfactorily completed.

1.08 WARRANTY
   A. National Project Performance Guarantee: Provide a guarantee on AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems" forms stating that AABC will assist in completing requirements of the Contract Documents if TAB firm fails to comply with the Contract Documents. Guarantee includes the following provisions:
      1. The certified TAB firm has tested and balanced systems according to the Contract Documents.
      2. Systems are balanced to optimum performance capabilities within design and installation limits.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.01 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 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 01 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 ceiling plenums used for supply, return, or relief air to verify that they are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.

F. Examine equipment performance data including fan and pump curves. 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.

G. 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.

H. Examine system and equipment test reports.

I. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

J. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

K. 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.

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. This includes dampers in fan powered boxes and rooftop units.
   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. Interlocked systems are operating.
   7. 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.

3.02 PREPARATION

A. Prepare a TAB plan that includes strategies and step-by-step procedures.

   1. Equipment and systems to be tested.
   3. Instrumentation to be used.
   4. Sample forms with specific identification for all equipment.
B. Complete system readiness checks and prepare system readiness reports. Verify the following:
   1. Permanent electrical power wiring is complete.
   2. Automatic temperature-control systems are operational.
   3. Equipment and duct access doors are securely closed.
   4. Balance, smoke, and fire dampers are open.
   5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   6. Windows and doors can be closed so indicated conditions for system operations can be met.

7. Airside:
   a. Verify that leakage and pressure tests on air distribution systems have been satisfactorily completed.
   b. Duct systems are complete with terminals installed.
   c. Volume, smoke, and fire dampers are open and functional.
   d. Clean filters are installed.
   e. Fans are operating, free of vibration, and rotating in correct direction.
   f. Automatic temperature-control systems are operational.
   g. Ceilings are installed.
   h. Windows and doors are installed.
   i. Suitable access to balancing devices and equipment is provided.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING
A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning 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. After testing and balancing, install test ports and duct access doors that comply with Section 233300 "Air Duct Accessories".
D. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, fan-speed-control levers, and similar controls and devices, to show final settings.
E. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 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. Prepare schematic diagrams of systems' "as-built" duct layouts.
C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
D. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of unit components.

K. Check for proper sealing of air duct system.

3.05 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 total airflow.
   a. Set outside-air and return-air dampers for proper position that simulates minimum outdoor-air conditions.
   b. Where duct conditions allow, measure airflow by main Pitot-tube traverse. If necessary, perform multiple Pitot-tube traverses, close to the fan and prior to any outlets, to obtain total airflow.
   c. Where duct conditions are not suitable for Pitot-tube traverse measurements, a coil traverse may be acceptable.

2. Measure fan static pressures as follows:
   a. Measure static pressure directly at the fan outlet or through the flexible connection.
   b. Measure static pressure directly at the fan inlet or through the flexible connection.
   c. Measure static pressure across each component that makes up the split system.
   d. Report artificial loading of filters at the time static pressures are measured.

3. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

4. Obtain approval from commissioning authority for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for split system units for adjustment of fans, belts, and pulley sizes to achieve indicated split system unit performance.

5. 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 occurs. Measure amperage in full-cooling, full-heating, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows.
1. Measure airflow of submain and branch ducts.
2. Adjust submain and branch duct volume dampers for specified airflow.
3. Re-measure each submain and branch duct after all have been adjusted.

C. Adjust air inlets and outlets for each space to indicated airflows.
   1. Set airflow patterns of adjustable outlets for proper distribution without drafts.
   2. Measure inlets and outlets airflow.
   3. Adjust each inlet and outlet for specified airflow.
   4. Re-measure each inlet and outlet after they have been adjusted.

D. Verify final system conditions.
   1. Re-measure and confirm that minimum outdoor and return airflows are within design. Readjust to design if necessary.
   2. Re-measure and confirm that total airflow is within design.
   3. Re-measure all final fan operating data, rpms, volts, amps, and static profile.
   4. Mark all final settings.
   5. Verify proper operation and adjust if necessary.
   6. Measure and record all operating data.
   7. Record final fan-performance data.

3.06 PROCEDURES FOR MOTORS
   A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
      1. Manufacturer, model, and serial numbers.
      4. Efficiency rating.
      5. Nameplate and measured voltage, each phase.
      6. Nameplate and measured amperage, each phase.
      7. Starter thermal-protection-element rating.
   B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.07 PROCEDURES FOR CONDENSING UNITS
   A. Verify proper rotation of fans.
   B. Measure entering- and leaving-air temperatures.
   C. Record compressor, fan, and motor operating data.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS
   A. Fan Coils: Measure the following data for each refrigerant coil:
      1. Nameplate data.
      2. Airflow.
3. Entering
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.

3.09 **DUCT LEAKAGE TESTS**
   A. Witness the duct pressure testing performed by Installer.
   B. Verify that proper test methods are used and that leakage rates are within specified tolerances.
   C. Report deficiencies observed.

3.010 **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.

3.011 **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 dampers.
   F. Check the sequence of operation of control devices. Note air pressures and device positions and correlate with airflow 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. Check main control supply-air pressure and observe compressor and dryer operations.
   J. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.
   K. Note operation of electric actuators using spring return for proper fail-safe operations.

3.012 **CONTROLS VERIFICATION**
   A. In conjunction with system balancing, perform the following:
1. Verify temperature control system is operating within the design limitations.
2. Verify that controllers are calibrated and function as intended.
3. Verify that controller set points are as indicated.
4. Verify the operation of lockout or interlock systems.
5. Verify the operation of damper actuators.
6. Verify that controlled devices are properly installed and connected to correct controller.
7. Verify that controlled devices travel freely and are in position indicated by controller: open, closed, or modulating.
8. Verify location and installation of sensors to ensure that they sense only intended temperature, humidity, or pressure.

B. Reporting: Include a summary of verifications performed, remaining deficiencies, and variations from indicated conditions.

3.013 TOLERANCES
A. Set HVAC system airflow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.

3.014 REPORTING
A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
B. Status Reports: As Work progresses, prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.015 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. Final Report Contents: In addition to certified field report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.
D. 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. Architect's name and address.
6. Engineer's name and address.
7. Contractor's name and address.
9. Signature of TAB firm who certifies the report.
10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
11. 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.
12. Nomenclature sheets for each item of equipment.
13. Data for units, including manufacturer, type size, and fittings.
14. Notes to explain why certain final data in the body of reports varies from indicated values.
15. Test conditions for fans 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. Face and bypass damper settings at coils.
   e. Fan drive settings
   f. Settings for supply-air, static-pressure controller.
   g. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
4. 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, and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
5. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm.
   b. Total system static pressure in inches wg.
   c. Fan rpm.
   d. Discharge static pressure in inches wg.
   e. Filter static-pressure differential in inches wg.
   f. Cooling coil static-pressure differential in inches wg.
   g. Heating coil static-pressure differential in inches wg.
   h. Outside airflow in cfm.
   i. Return airflow in cfm.
   j. Outside-air damper position.
   k. Return-air damper position.

F. Apparatus-Coil Test Reports:
   1. Coil Data:
      a. System identification.
      b. Location.
      c. Coil type.
      d. Number of rows.
      e. Fin spacing in fins per inch o.c.
      f. Make and model number.
      g. Face area in sq. ft..
      h. Tube size in NPS.
      i. Tube and fin materials.
      j. Circuiting arrangement.
   2. Test Data (Indicated and Actual Values):
      a. Airflow rate in cfm.
      b. Average face velocity in fpm.
      c. Air pressure drop in inches wg.
      d. Outside-air, wet- and dry-bulb temperatures in deg F.
      e. Return-air, wet- and dry-bulb temperatures in deg F.
      f. Entering-air, wet- and dry-bulb temperatures in deg F.
      g. Leaving-air, wet- and dry-bulb temperatures in deg F.
      h. Water pressure differential in feet of head or psig.
      i. Entering-water temperature in deg F.
      j. Leaving-water temperature in deg F.
      k. Refrigerant expansion valve and refrigerant types.
      l. Refrigerant suction pressure in psig.
      m. Refrigerant suction temperature in deg F.
G. Round and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
   1. Report Data:
      a. System number.
      b. Location and zone.
      c. Traverse air temperature in deg F.
      d. Duct static pressure in inches wg.
      e. Duct size in inches.
      f. Duct area in sq. ft.
      g. Indicated airflow rate in cfm.
      h. Indicated velocity in fpm.
      i. Actual airflow rate in cfm.
      j. Actual average velocity in fpm.
      k. Barometric pressure in psig.

H. Fan Test Reports: For supply, return, and 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, and bore.
      h. Sheave dimensions, center-to-center, and amount of adjustments in inches.
   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, and bore.
      f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
      g. Number of belts, make, and size.
   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm.
      b. Total system static pressure in inches wg.
      c. Fan rpm.
      d. Discharge static pressure in inches wg.
      e. Suction static pressure in inches wg.

I. Fan Test Reports: For supply, return, and 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, and bore.
h. Sheave dimensions, center-to-center, and amount of adjustments in inches.

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, and bore.
f. Sheave dimensions, center-to-center, and amount of adjustments in inches.
g. Number of belts, make, and size.

3. Test Data (Indicated and Actual Values):
a. Total airflow rate in cfm.
b. Total system static pressure in inches wg.
c. Fan rpm.
d. Discharge static pressure in inches wg.
e. Suction static pressure in inches wg.

J. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
a. System and Rooftop unit number.
b. Location and zone.
c. Traverse air temperature in deg F.
d. Duct static pressure in inches wg.
e. Duct size in inches.
f. Duct area in sq. ft..
g. Indicated airflow rate in cfm.
h. Indicated velocity in fpm.
i. Actual airflow rate in cfm.
j. Actual average velocity in fpm.
k. Barometric pressure in psig.

K. Instrument Calibration Reports:
1. Report Data:
a. Instrument type and make.
b. Serial number.
c. Application.
d. Dates of use.
e. Dates of calibration.

3.016 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. Measure sound levels at two locations.
   d. Measure space pressure of at least 10 percent of locations.
   e. 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 owner.
2. TAB firm test and balance engineer shall conduct the inspection in the presence of owner.
3. Owner 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.
4. 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."
5. 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.
6. 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.
7. 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
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
   2. Fire-rated insulation systems.
   3. Insulating cements.
   4. Adhesives.
   5. Mastics.
   7. Sealants.
   8. Factory-applied jackets.
   10. Field-applied cloths.
   11. Field-applied jackets.
   12. Tapes.
   13. Securements.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230529 Hangers and Supports for HVAC Piping and Equipment.

B. Section 230500 Common Work Results For HVAC.

C. Section 233113 Metal Ducts.
1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Qualification Data: For qualified Installer.

C. 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 and test methods employed.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
B. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.08 SCHEDULING

A. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

1.01 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; Duct Wrap.
      b. Johns Manville; Microlite.
      c. Knauf Insulation; Duct Wrap.
      d. Manson Insulation Inc.; Alley Wrap.
      e. Owens Corning; All-Service Duct Wrap.
H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glas.
   d. Knauf Insulation; Insulation Board.
   e. Manson Insulation Inc.; AK Board.
   f. Owens Corning; Fiberglas 700 Series.

1.02 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide up to 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. CertainTeed Corp.; FlameChek.
   b. Johns Manville; Firetemp Wrap.
   d. Thermal Ceramics; FireMaster Duct Wrap.
   e. 3M; Fire Barrier Wrap Products.
   f. Unifrax Corporation; FyreWrap.
   g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

1.03 INSULATING CEMENTS

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Insulco, Division of MFS, Inc.; Triple I.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
1. Products: Subject to compliance with requirements, provide one of the following:

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Insulco, Division of MFS, Inc.; SmoothKote.
   c. Rock Wool Manufacturing Company; Delta One Shot.
1.04 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-96.

C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-96.

F. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.
1.05 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-35.
      b. Foster Products Corporation, H. B. Fuller Company; 30-90.
      c. ITW TACC, Division of Illinois Tool Works; CB-50.
      d. Marathon Industries, Inc.; 590.
      e. Mon-Eco Industries, Inc.; 55-40.
      f. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
   3. Service Temperature Range: Minus 20 to plus 180 deg F.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-30.
      b. Foster Products Corporation, H. B. Fuller Company; 30-35.
      c. ITW TACC, Division of Illinois Tool Works; CB-25.
      e. Mon-Eco Industries, Inc.; 55-10.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
   3. Service Temperature Range: 0 to 180 deg F.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Encacel.
      b. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.
      c. Marathon Industries, Inc.; 570.
      d. Mon-Eco Industries, Inc.; 55-70.
   2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
   3. Service Temperature Range: Minus 50 to plus 220 deg F.
   4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-10.
   b. Foster Products Corporation, H. B. Fuller Company; 35-00.
   c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
   e. Mon-Eco Industries, Inc.; 55-50.
   f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F.
4. Solids Content: 63 percent by volume and 73 percent by weight.

1.06 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-52.
   b. Foster Products Corporation, H. B. Fuller Company; 81-42.
   c. Marathon Industries, Inc.; 130.
   d. Mon-Eco Industries, Inc.; 11-30.
   e. Vimasco Corporation; 136.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.

1.07 SEALANTS

A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
   b. Foster Products Corporation, H. B. Fuller Company; 30-45.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Pittsburgh Corning Corporation; Pittseal 444.
   f. Vimasco Corporation; 750.
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-70.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76-8.
   b. Foster Products Corporation, H. B. Fuller Company; 95-44.
   c. Marathon Industries, Inc.; 405.
   d. Mon-Eco Industries, Inc.; 44-05.
   e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.

1.08 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

   a. Products: Subject to compliance with requirements, provide one of the following:
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

1.09 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Chil-Glas No. 5.

B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
   1. Products: Subject to compliance with requirements, provide one of the following:
      b. Vimasco Corporation; Elastafab 894.

1.010 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.
   1. Products: Subject to compliance with requirements, provide one of the following:

1.011 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Zeston.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
      a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
   5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.
      a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
      b. Finish and thickness are indicated in field-applied jacket schedules.
      c. Moisture Barrier for Indoor Applications: 2.5-mil-thick, heat-bonded polyethylene and kraft paper.
      d. Moisture Barrier for Outdoor Applications: 3-mil thick Polysurlyn.
      e. Factory-Fabricated Fitting Covers:
         1) Same material, finish, and thickness as jacket.
         2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
         3) Tee covers.
         4) Flange and union covers.
         5) End caps.
         6) Beveled collars.
         7) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
E. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.

1.012 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   3. Thickness: 11.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lb/inch in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches.
   3. Thickness: 6.5 mils.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lb/inch in width.
   7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
      b. Compac Corp.; 130.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
d. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 4 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
2. Width: 3 inches.
3. Film Thickness: 6 mils.
4. Adhesive Thickness: 1.5 mils.
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch in width.

1.013 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products; Bands.
b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing or closed seal.

3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch 3/4 inch wide with wing or closed seal.


B. Insulation Pins and Hangers: Note that insulation pins shall NOT BE USED for cooled, dehumidified supply/return air insulation. Use for heated air systems only.

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch- diameter shank, length to suit depth of insulation indicated.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
   c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
      2) GEMCO; Press and Peel.
      3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel or aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) GEMCO.
2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

D. Wire: 0.062-inch soft-annealed, galvanized steel.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      b. Childers Products.
      c. PABCO Metals Corporation.
      d. RPR Products, Inc.

1.014 CORNER ANGLES

A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch aluminum according to ASTM B 209, Alloy 3003, 3005, 3105 or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

PART 3 - EXECUTION

1.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

1.02 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
1. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

1.03 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install 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. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install 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 2 inches o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above ambient services, do not install insulation to the following:
   1. Testing agency labels and stamps.
   2. Nameplates and data plates.
   4. Handholes.
   5. Cleanouts.
1.04 PENETRATIONS

A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
   4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations: Install insulation continuously through walls and partitions.

1.05 MINERAL-FIBER INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, 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 either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
      a. On duct sides with dimensions 18 inches and smaller, place pins 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, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
      c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
      d. Do not overcompress insulation during installation.
      e. Impale insulation over pins and attach speed washers.
      f. 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.
   4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install 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 insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, 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 either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches and smaller, place pins 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 pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. 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.

4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
   a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

1.06 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:
   1. Install pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of 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 same thickness as pipe insulation.
   4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install mitered sections of pipe insulation.
   2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

1.07 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
   1. Draw 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 lagging adhesive.
   3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket 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-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

D. Where metal jackets are indicated, install 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.

E. Where PVDC jackets are indicated, install as follows:
   1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
   2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
   3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
   4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
   5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

1.08 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

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.

D. Do not field paint aluminum or stainless-steel jackets.

1.09 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:
   1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
   2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

1.010 DUCT INSULATION SCHEDULE, GENERAL

A. Supply and return air duct shall be internally lined where specified on drawings, refer to Division 23 “metal ducts” for specification and drawings for exact locations.

B. Supply, return, and outside air duct shall be externally lined:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick with minimum of R-6 rating with FSK jacket.

C. Items Not Insulated:
   1. Exhaust ductwork
   2. Factory-insulated flexible ducts.
   3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

1.011 PLENUM INSULATION SCHEDULE

A. Concealed plenum insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick with minimum of R-6 rating with FSK jacket.

B. Concealed plenum insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 1-1/2 inches thick with minimum of R-6 rating with FSK jacket.

1.012 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Exposed piping less than twelve feet above finished floor shall have PVC jacketing, including elbows.

1.013 INDOOR PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.

C. Condensate and Equipment Drain Water:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 3/4 inch thick.

1.014 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.

B. Refrigerant Suction and Hot-Gas Flexible Tubing:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch thick.
1.015 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Piping, Concealed or exposed:
   1. If piping is not insulated, no jacket is required.
   2. If piping is insulated, provide aluminum jacket.

D. Piping, Exposed:
   1. Aluminum, Smooth with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION 23 07 00
SECTION 23 31 13 - METAL DUCTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes metal ducts for supply, return, outside, and exhaust air-distribution systems in pressure classes as follows: (As per SMACNA).
   1. Rectangular and round ducts and fittings: -2” w.g. to +2” w.g.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230593 Testing, Adjusting, and Balancing For HVAC.
B. Section 233300 Air Duct Accessories.

1.04 DEFINITIONS

A. FRP: Fiberglass-reinforced plastic.

1.05 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.

1.06 SUBMITTALS

A. Shop Drawings: CAD-generated and drawn 1/8 inch equals 1 foot minimum scale or BIM model. Show fabrication and installation details for metal ducts. Shop drawings are required for review before construction.
   1. Plans, elevations and sectional drawings are required.
   2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Duct layout indicating sizes and pressure classes.
4. Elevations of top and bottom of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Duct accessories, including access doors and panels.
12. Hangers and supports, including methods for duct and building attachments.

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. Other systems installed in same space as ducts.
3. Ceiling- and wall-mounting access doors and panels required to provide access to dampers and other operating devices.
4. Ceiling-mounting items, including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Welding certificates.

D. Field quality-control test reports.

1.07 QUALITY ASSURANCE


B. 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

1.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
1.02 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. 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. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets; commercial quality; with oiled, matte finish for exposed ducts.

D. Stainless Steel: ASTM A 480/A 480M, Type 316 or 304, and having a No. 2D finish for concealed ducts and for exposed ducts.

E. Aluminum Sheets: ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

1.03 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, nonsag, 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.

1.04 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. Obtain written permission from Architect or Owner before fastening to concrete structural members.
1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized sheet steel or threaded steel rod.
1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
2. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for steel sheet width and thickness and for steel rod diameters.
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.

1.05 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. Available 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. Available 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.

PART 3 - EXECUTION

1.01 DUCT APPLICATIONS

A. Static-Pressure Classes: Unless otherwise indicated, construct ducts according to the following:
   1. Supply Ducts: 2-inch wg.
   2. Return Ducts (Negative Pressure): 2-inch wg.

1.02 DUCT INSTALLATION

A. Construct and install ducts according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.

B. Install ducts with fewest possible joints.

C. Where mitered elbows must be used, provide air foil turning vanes.

D. Flex duct may be used for may be used for low pressure ductwork. The length of the flex ducts should not exceed 5 feet. Flex duct runs should not contain any bends.

E. Install fabricated fittings for changes in directions, size, and shape and for connections.

F. 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.

G. Install ducts, unless otherwise indicated, vertically and horizontally and parallel and perpendicular to building lines; avoid diagonal runs.
H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions unless specifically indicated.

K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

L. Seal all joints and seams. Apply sealant to male end connectors before insertion, and afterward to cover entire joint and sheet metal screws.

M. Electrical Equipment Spaces: Route ducts to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

N. 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.

O. Protect duct interiors from the elements and foreign materials until building is enclosed. Follow SMACNA's "Duct Cleanliness for New Construction."

1.03 **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.

1.04 **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.
D. Install concrete inserts before placing concrete.

E. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   1. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

1.05 CONNECTIONS

A. Make connections to equipment with flexible connectors according to Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

1.06 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section "Interior Painting."

1.07 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 and flat-oval ducts, Leakage Class 12 for rectangular ducts in pressure classes lower than and equal to 2-inch wg (both positive and negative pressures), and Leakage Class 6 for pressure classes from 2- to 10-inch wg.
   4. Remake leaking joints and retest until leakage is equal to or less than maximum allowable.

1.08 CLEANING NEW SYSTEMS

A. Mark position of dampers and air-directional mechanical devices before cleaning, and perform cleaning before air balancing.

B. Use service openings, as required, for physical and mechanical entry and for inspection.
   1. Create other openings to comply with duct standards.
2. Disconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling sections to gain access during the cleaning process.

C. Vent vacuuming system to the outside. Include filtration to contain debris removed from HVAC systems, and locate exhaust down wind and away from air intakes and other points of entry into building.

D. Clean the following metal duct systems by removing surface contaminants and deposits:
1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
5. Return-air ducts, dampers, and actuators except in ceiling plenums and mechanical equipment rooms.

E. Mechanical Cleaning Methodology:
1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, or duct accessories.
4. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

F. Cleanliness Verification:
1. Visually inspect metal ducts for contaminants.
2. Where contaminants are discovered, re-clean and reinspect ducts.

END OF SECTION 23 31 13
SECTION 23 33 00 - AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Backdraft dampers.
   2. Volume dampers.
   3. Motorized control dampers
   4. Turning vanes.
   5. Duct-mounting access doors.
   6. Flexible connectors.
   7. Flexible ducts.
   8. Duct accessory hardware.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230593 Testing, Adjusting, and Balancing For HVAC.

B. Section 233113 Metal Ducts.

1.04 SUBMITTALS

A. Product Data: For the following:
   1. Backdraft dampers.
   2. Volume dampers.
   3. Motorized control dampers
   4. Turning vanes.
   5. Duct-mounting access doors.
   6. Flexible connectors.
   7. Flexible ducts.
   8. Duct accessory hardware.

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. Motorized-control damper installations.
4. **Wiring Diagrams:** Power, signal, and control wiring.

   C. **Coordination Drawings:** Reflected ceiling plans, drawn to scale and coordinating penetrations and ceiling-mounting items. Show ceiling-mounting access panels and access doors required for access to duct accessories.

### 1.05 QUALITY ASSURANCE


### 1.06 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.

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**PART 2 - PRODUCTS**

### 1.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### 1.02 SHEET METAL MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated.

B. **Galvanized Sheet Steel:** Lock-forming quality; complying with ASTM A 653/A 653M and having G90 coating designation; ducts shall have mill-phosphatized finish for surfaces exposed to view.

C. **Stainless Steel:** ASTM A 480/A 480M.

D. **Aluminum Sheets:** ASTM B 209, alloy 3003, temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. **Extruded Aluminum:** ASTM B 221, alloy 6063, temper T6.

F. **Reinforcement Shapes and Plates:** Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. **Tie Rods:** Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.
1.03 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: 0.052-inch thick galvanized sheet steel, 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: Galvanized Steel.

H. Return Spring: Adjustable tension.

1.04 VOLUME DAMPERS

A. Available 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: 0.125-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: Hat-shaped, galvanized 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, 0.125-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: 0.125-inch-thick extruded aluminum.
   7. Bearings: Oil-impregnated bronze or Molded synthetic or 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.
1.05 MOTORIZED CONTROL DAMPERS

A. Manufacturers:
   1. Air Balance, Inc.
   2. American Warming and Ventilating.
   3. CESCO Products.
   4. Duro Dyne Corp.
   5. Greenheck.
   7. METALAIRE, Inc.
   8. Nailor Industries Inc.
   10. Ruskin Company.

B. General Description: AMCA-rated, opposed-blade design; minimum of 0.1084-inch thick, galvanized-steel frames with holes for duct mounting; minimum of 0.0635-inch thick, galvanized-steel damper blades with maximum blade width of 8 inches.
   1. Secure blades to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
   2. Operating Temperature Range: From minus 40 to plus 200 deg F.
   3. Provide opposed-blade design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is being held by torque of 50 in. x lbf; when tested according to AMCA 500D].

1.06 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for vanes and vane runners. Vane runners shall automatically align vanes.

B. Manufactured Turning Vanes: Fabricate 1-1/2-inch-wide, single-vane, curved blades of galvanized sheet steel set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into vane runners suitable for duct mounting.
   1. Manufacturers:
      a. Ductmate Industries, Inc.
      b. Duro Dyne Corp.
      c. METALAIRE, Inc.
      d. Ward Industries, Inc.
C. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

1.07 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. Provide air tight gasketing all around door opening.
   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 and inside handles.
      d. Sizes 24 by 48 Inches and Larger: One additional hinge.

C. Door: Double wall, duct mounting, and round; fabricated of galvanized sheet metal with insulation fill and 1-inch thickness. Include cam latches.
   1. Available Manufacturers:
      a. Ductmate Industries, Inc.
      b. Flexmaster U.S.A., Inc.
   2. Frame: Galvanized sheet steel, with spin-in notched frame.

D. Pressure Relief Access Door: Double wall and duct mounting; fabricated of galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class. Include vision panel where indicated, latches, and retaining chain.
   1. Available Manufacturers:
      a. American Warming and Ventilating.
      b. CESCO Products.
      c. Ductmate Industries, Inc.
d. Greenheck.

e. KEES, Inc.


g. Nexus PDQ.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

E. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

F. Insulation: 1-inch-thick, fibrous-glass or polystyrene-foam board.

1.08 FLEXIBLE CONNECTORS

A. Available 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 approximately 5-3/4 inches wide attached to two strips of 2-3/4-inch wide, 0.028-inch thick, galvanized sheet steel. 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.

1.09 FLEXIBLE DUCTS

A. Available Manufacturers:
   1. Flexmaster U.S.A., Inc.
   2. Hart & Cooley, Inc.
   4. Thermaflex

B. Insulated-Duct Connectors: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or 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
   4. Minimum R-value = 6.0
C. Flexible Duct Clamps: Nylon strap, in sizes 3 through 18 inches to suit duct size.

1.010 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

1.01 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, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers in ducts with liner; avoid damage to and erosion of duct liner.

D. 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.

E. Provide test holes at fan inlets and outlets and elsewhere as indicated.

F. 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.

G. 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.

H. Install the following sizes for duct-mounting, pressure relief access doors:
   1. One-Hand or Inspection Access: 7 inches in diameter.

I. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment."

J. Install flexible connectors immediately adjacent to equipment in ducts associated with fans and motorized equipment supported by vibration isolators.

K. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.

L. Connect diffusers or light troffer boots to low pressure ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.

M. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.

N. Install duct test holes where indicated and required for testing and balancing purposes.

1.02 ADJUSTING

A. Adjust duct accessories for proper settings.

B. Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

END OF SECTION 23 33 00
SECTION 23 34 23 - HVAC POWER VENTILATORS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. In-line centrifugal fans.
   2. Sidewall propeller fans.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230593 Testing, Adjusting, and Balancing For HVAC.
B. Section 233113 Metal Ducts.
C. Section 233300 Air Duct Accessories.
D. Section 230553 Identification For HVAC Piping and Equipment.

1.04 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on actual Project site elevations.
B. Operating Limits: Classify according to AMCA 99.

1.05 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.
   6. Fan speed controllers.
B. Coordination Drawings: Reflected ceiling plans and other details, 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. Size and location of initial access modules for acoustical tile.
   3. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.06 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.

1.07 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.

1.08 COORDINATION

A. Coordinate size and location of structural-steel support members.
PART 2 - PRODUCTS

1.01 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck
   2. Cook
   3. Dayton

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. Companion Flanges: For inlet and outlet duct connections.
   2. Motor and Drive Cover (Belt Guard): Epoxy-coated steel.

G. Capacities and Characteristics: See schedule.

1.02 SIDEWALL PROPELLER FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck
   2. Cook
   3. Dayton

B. Housing: Galvanized-steel sheet with flanged edges and integral orifice ring, with baked-enamel finish coat applied after assembly.

C. Fan Wheels: Formed-steel blades riveted to heavy-gauge steel spider bolted to cast-iron hub.

D. Fan Wheel: Replaceable, cast-aluminum, airfoil blades fastened to cast-aluminum hub; factory set pitch angle of blades.

E. Fan Drive: Direct-drive motor mounted in airstream, factory wired to disconnect switch located on outside of fan housing.
F. Accessories:
   1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
   2. Dampers: Counterbalanced, parallel-blade, backdraft dampers factory set to close when fan stops.
   3. Motorized Dampers: Parallel-blade dampers with electric actuator wired to close when fan stops.
   5. Wall Sleeve: Galvanized steel to match fan and accessory size.
   6. Weathershield Hood: Galvanized steel to match fan and accessory size.
   7. Weathershield Front Guard: Galvanized steel with expanded metal screen.

1.03 MOTORS
   A. ECM motors with less than 10% voltage spike/loss tolerance.
   B. Enclosure Type: Totally enclosed, fan cooled.

1.04 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."
   C. UL Standards: Power ventilators shall comply with UL 705.

PART 3 - EXECUTION

1.01 INSTALLATION
   A. Install power ventilators level and plumb.
   B. Support units using elastomeric mounts having a static deflection of 1 inch.
C. Support suspended units from structure using threaded steel rods and elastomeric hangers.

D. Install units with clearances for service and maintenance.

E. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

1.02 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 "Air 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 for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

E. Install control and electrical power wiring to field-mounted control devices.

1.03 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 connections 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. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation.
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.
   7. Verify that manual and automatic volume control and fire dampers in connected ductwork systems are in fully open position.
   8. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   9. Shut unit down and reconnect automatic temperature-control operators.
  10. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
1.04 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

C. Replace fan and motor pulleys as required to achieve design airflow.

D. Lubricate bearings

END OF SECTION 23 34 23
SECTION 23 37 13 - DIFFUSERS, REGISTERS, AND GRILLS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230593 Testing, Adjusting, and Balancing For HVAC.

B. Section 233300 Air Duct Accessories.

1.04 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, Register, and Grille Schedule: Indicate Drawing designation, room location, 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, grilles, speakers, sprinklers, access panels, and special moldings.
   5. Duct access panels.

C. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

D. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.
PART 2 - PRODUCTS

1.01 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1.02 GRILLES AND REGISTERS

A. Fixed Face Grille or Register:
   1. Manufacturers:
      a. Krueger.
      b. Nailor Industries of Texas Inc.
      c. Price Industries.
      d. Titus.
      e. Tuttle & Bailey.
      f. Metalaire.
   2. Features and accessories: See schedule.

1.03 CEILING DIFFUSER OUTLETS

A. Square Ceiling Diffusers:
   1. Available Manufacturers:
      a. Krueger.
      b. METALAIRE, Inc.; Metal Industries Inc.
      c. Nailor Industries of Texas Inc.
      d. Price Industries.
      e. Titus.
      f. Tuttle & Bailey.
   2. Features and accessories: See schedule.

1.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."
PART 3 - EXECUTION

1.01 EXAMINATION

A. Examine areas where diffusers, registers, 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.

1.02 INSTALLATION

A. Install diffusers, registers, 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, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

1.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
SECTION 23 81 26 - SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:

1. Indoor, concealed, ceiling-mounted units for ducting.
2. Indoor, exposed, wall-mounted units.
3. Outdoor, air-source, heat-pump units.
4. System controls.
5. System refrigerant and oil.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. Section 230593 Testing, Adjusting, and Balancing For HVAC.

B. Section 233300 Air Duct Accessories.

C. Section 233113 Metal Ducts.

D. Section 230553 Identification For HVAC Piping and Equipment.

1.04 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics. Refrigerant piping type, pressure rating, and sizes.

B. Shop Drawings: Refrigerant routing, Diagram power, signal, and control wiring.

C. Schematics: Refrigerant piping diagrams showing condenser unit, evaporator fan units, distribution header, all refrigerant piping sizes, and all refrigerant piping accessories.

D. Field quality-control test reports.
E. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

F. Warranty: Special warranty specified in this Section.

1.05 COORDINATION

A. Coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.06 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of split-system units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

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.


D. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

E. Units shall be designed to operate with HCFC-free refrigerants.

F. The evaporator fans and condenser unit shall be manufacturer by the same manufacturer.

G. Manufacturer Qualifications:

1. Nationally recognized manufacturer of VRF HVAC systems and products.
2. Shipped VRF HVAC systems with similar requirements to those indicated for a continuous period of 10 years within time of bid.
3. VRF HVAC systems and products that have been successfully tested and in use on at least five completed projects.
4. Having complete published catalog literature, installation, and operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
   a. Product research and development.
   b. Product and application engineering.
   c. Product manufacturing, testing, and quality control.
   d. Technical support for system installation training, startup, commissioning, and troubleshooting of installations.
   e. Owner training.
H. Factory-Authorized Service Representative Qualifications:

1. Authorized representative of, and trained by, VRF HVAC system manufacturer.
2. Demonstrated past experience with products being installed for period within five consecutive years before time of bid.
3. Demonstrated past experience on five projects of similar complexity, scope, and value.
   a. Each person assigned to Project shall have demonstrated past experience.
4. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
5. Service and maintenance staff assigned to support Project during warranty period.
6. Product parts inventory to support ongoing system operation for a period of not less than five years after Substantial Completion.
7. VRF HVAC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

I. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by VRF HVAC system manufacturer.

1. Each employee shall be certified by manufacturer for proper installation of systems, including, but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
2. Installer certification shall be valid and current for duration of Project.
3. Retain copies of Installer certificates on-site and make available on request.
4. Each person assigned to Project shall have demonstrated past experience.
   a. Demonstrated past experience with products being installed for period within three consecutive years before time of bid.
   b. Demonstrated past experience on five projects of similar complexity, scope, and value.

1.07 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

1.08 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. Filters: Two sets of filters for each unit.
2. Fan Belts: Two sets of belts for each unit.
PART 2 - PRODUCTS

1.01 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. Trane
   2. Lennox
   3. Carrier
   4. LG

C. Source Limitations: Obtain products from single source from single manufacturer including, but not limited to, the following:
   1. Indoor and outdoor units, including accessories.
   2. Controls and software.
   3. HRCUs.
   4. Refrigerant isolation valves.
   5. Specialty refrigerant pipe fittings.

1.02 SYSTEM DESCRIPTION

A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit, piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
   1. Two-pipe system design.
   2. System(s) operation, heat pump as indicated on Drawings.
   3. Each system with one refrigerant circuit shared by all indoor units connected to system.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.

D. ASHRAE Compliance:
   1. ASHRAE 15: For safety code for mechanical refrigeration.
   2. ASHRAE 62.1: For indoor air quality.
   3. ASHRAE 135: For control network protocol with remote communication.
   4. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.

E. UL Compliance: Comply with UL 1995.
1.03 INDOOR UNITS (DUCTED)

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.

B. Cabinet:

1. Material: Galvanized or painted steel.
2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
4. Mounting: Manufacturer-designed provisions for field installation.
5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:

1. Coil Casing: Aluminum, galvanized, or stainless steel.
2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
3. Coil Tubes: Copper, of diameter and thickness required by performance.
4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
5. Unit Internal Tubing: Copper tubing with brazed joints.
6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
7. Field Piping Connections: Manufacturer's standard.
8. Factory Charge: Dehydrated air or nitrogen.
9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:

1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.

E. Fan and Motor Assembly:

1. Fan(s):
   a. Direct-drive arrangement.
   b. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
   c. Wheels statically and dynamically balanced.

2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
4. Speed Settings and Control: Three (low, medium, high), or more than three speed settings or variable speed with a speed range of at least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
   2. Efficiency: 2” MERV 8.
   3. Media:
      a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.

G. Unit Accessories:
   1. Outdoor Air Ventilation Kit: Connection, motorized damper, and control sized to allow sequence of operation indicated on Drawings.
   2. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.

H. Unit Controls:
   1. Enclosure: Metal, suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   3. Factory-Installed Sensors:
      a. Unit inlet air temperature.
      b. Coil entering refrigerant temperature.
      c. Coil leaving refrigerant temperature.
   4. Features and Functions:
      a. Self-diagnostics.
      b. Time delay.
      c. Auto-restart.
      d. External static pressure control.
      e. Auto operation mode.
      f. Manual operation mode.
      g. Filter service notification.
      h. Power consumption display.
      i. Drain assembly high water level safety shutdown and notification.
      j. Run test switch.
   5. Communication: Network communication with other indoor and outdoor unit.
   6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
1.04 WALL-MOUNTING, EVAPORATOR-FAN COMPONENTS

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.

B. Cabinet:
   1. Material: Painted steel, or coated steel frame covered by a plastic cabinet.
   2. Insulation: Manufacturer's standard internal insulation to provide thermal resistance and prevent condensation.
   3. Mounting: Manufacturer-designed provisions for field installation.
   4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. DX Coil Assembly:
   1. Coil Casing: Aluminum, galvanized, or stainless steel.
   2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
   3. Coil Tubes: Copper, of diameter and thickness required by performance.
   4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
   5. Unit Internal Tubing: Copper tubing with brazed joints.
   6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   7. Field Piping Connections: Manufacturer's standard.
   8. Factory Charge: Dehydrated air or nitrogen.
   9. Testing: Factory pressure tested and verified to be without leaks.

D. Drain Assembly:
   1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
      a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.

E. Fan and Motor Assembly:
   1. Fan(s):
      a. Direct-drive arrangement.
      b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
      c. Wheels statically and dynamically balanced.
   2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
4. Speed Settings and Control: Three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.

F. Filter Assembly:
   1. Access: Front, to accommodate filter replacement without the need for tools.

G. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.

H. Unit Accessories:
   1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
   2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.

I. Unit Controls:
   1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
   2. Factory-Installed Controller: Configurable digital control.
   4. Communication: Network communication with other indoor units and outdoor unit(s).
   5. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
   6. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

1.05 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Description: Factory-assembled and tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
   1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
   2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
   3. All units installed shall be from the same product development generation.

B. Cabinet:
1. Galvanized steel and coated with a corrosion-resistant finish.
   a. Coating with documented salt spray test performance of 1000 hours according ASTM B117 surface scratch test (SST) procedure.

2. Mounting: Manufacturer-designed provisions for field installation.

3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.

C. Compressor and Motor Assembly:

1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity.

2. Protection: Integral protection against the following:
   a. High refrigerant pressure.
   b. Low oil level.
   c. High oil temperature.
   d. Thermal and overload.
   e. Voltage fluctuations.
   f. Phase failure and phase reversal.
   g. Short cycling.

3. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.


5. Oil management system to ensure safe and proper lubrication over entire operating range.

6. Crankcase heaters with integral control to maintain safe operating temperature.

7. Fusible plug.

D. Condenser Coil Assembly:

1. Plate Fin Coils:
   a. Casing: Aluminum, galvanized, or stainless steel.
   b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
   c. Tubes: Copper, of diameter and thickness required by performance.

2. Aluminum Microchannel Coils:
   b. Single- or multiple-pass arrangement.
   c. Construct fins, tubes, and header manifolds of aluminum alloy.

3. Coating: Corrosion resistant.
4. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

E. Condenser Fan and Motor Assembly:

1. Fan(s): Propeller type.
   a. Direct-drive arrangement.
   b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
   c. Statically and dynamically balanced.

2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.

3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.


5. Speed Settings and Control: Variable speed with a speed range of at least 75 percent.


F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.

G. Unit Controls:

1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.

2. Factory-Installed Controller: Configurable digital control.

3. Factory-Installed Sensors:
   a. Refrigerant suction temperature.
   b. Refrigerant discharge temperature.
   c. Outdoor air temperature.
   d. Refrigerant high pressure.
   e. Refrigerant low pressure.
   f. Oil level.

4. Features and Functions: Self-diagnostics, time delay, auto-restart, fuse protection, auto operation mode, manual operation mode, night setback control, power consumption display, run test switch, equalize run time between multiple same components.

5. Communication: Network communication with indoor units and other outdoor unit(s).

6. Cable and Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.

7. Field Connection: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
H. Unit Hardware: Zinc-plated steel, or stainless steel. Coat exposed surfaces with additional corrosion-resistant coating if required to prevention corrosion when exposed to salt spray test for 1000 hours according ASTM B117.

I. Unit Piping:
   1. Unit Tubing: Copper tubing with brazed joints.
   2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
   3. Field Piping Connections: Manufacturer's standard.
   4. Factory Charge: Dehydrated air or nitrogen.
   5. Testing: Factory pressure tested and verified to be without leaks.

1.06 SYSTEM CONTROLS

A. VRF HVAC System Operator Software for PC:
   1. Software offered by VRF HVAC system manufacturer shall provide system operators with ability to monitor and control VRF HVAC system(s) from a single dedicated Owner-furnished PC.
   2. Software shall provide operator with a graphic user interface to allow monitoring and control of multiple central controllers from a single device location through point-and-click mouse exchange.
   3. Plan views shall show building plans with location of indoor units and identification superimposed on plans.
   4. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
   5. Schedules operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Schedules daily, weekly, and annual events.
   6. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
   7. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
   8. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
   9. Supports Multiple Languages: English or Spanish.
  10. Supports Imperial and Metric Temperature Units: Fahrenheit or Celsius.
  11. Displays service notifications and error codes.
  12. Monitors and displays up to 3000 item error history and 10000 item operation history for regular reporting and further archiving.
  13. Monitors and displays cumulative operating time of indoor units.
  14. Able to disable and enable operation of individual controllers for indoor units.
  15. Information displayed on individual controllers shall also be available for display.
  16. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.
B. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
   a. Include multiple interconnected controllers as required.

2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.

3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
   a. Sets schedule for daily, weekly, and annual events.
   b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.

4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.

5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.

6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.

7. Service diagnostics tool.

8. Able to disable and enable operation of individual controllers for indoor units.

9. Information displayed on individual controllers shall also be available for display through central controller.

10. Information displayed for outdoor units, including refrigerant high and low pressures percent capacity.

11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.

12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

C. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.

2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.

3. Multiple Language: English or Spanish.

4. Temperature Units: Fahrenheit or Celsius.

5. On/Off: Turns indoor unit on or off.

6. Hold: Hold operation settings until hold is released.


8. Temperature Display: 1-degree increments.


10. Relative Humidity Display: 1 percent increments.

11. Relative Humidity Set-Point: Adjustable in 1 percent increments.

12. Fan Speed Setting: Select between available options furnished with the unit.
13. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
14. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
15. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
16. Occupancy detection.
17. Service Run Tests: Limit use by service personnel to troubleshoot operation.
18. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
20. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
21. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

1.07 REFRIGERANT PIPING

A. Performance Requirements:

1. Copper Tube: ASTM B280, Type ACR.
3. Brazing Filler Metals: AWS A5.8/A5.8M.

B. Refrigerant Tubing Kits:

1. Furnished by VRF HVAC system manufacturer.
2. Factory-rolled and -bundled, soft-copper tubing with tubing termination fittings at each end.
3. Standard one-piece length for connecting to indoor units.
4. Pre-insulated with 1” thick flexible elastomeric insulation of thickness to comply with governing energy code and sufficient to eliminate condensation.
5. Factory Charge: Dehydrated air or nitrogen.

C. Divided-Flow Specialty Fittings: Where required by VRF HVAC system manufacturer for proper system operation, VRF HVAC system manufacturer shall furnish specialty fittings with identification and instructions for proper installation by Installer.

D. Refrigerant Isolation Ball Valves:

1. Description: Uni-body full port design, rated for maximum system temperature and pressure, and factory tested under pressure to ensure tight shutoff. Designed for valve operation without removing seal cap.
2. Seals: Compatible with system refrigerant and oil. Seal service life of at least 20 years.
3. Valve Connections: Flare or sweat depending on size.
PART 3 - EXECUTION

1.01 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 products before installation. Reject products that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.

D. Examine roughing-in for ductwork to verify actual locations of connections before equipment installation.

E. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.

F. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.

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

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

1.02 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install evaporator components using manufacturer's standard mounting procedure.

D. Install ground-mounted, compressor-condenser components on cast-in place concrete equipment bases.

E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

F. Install piping and tubing to permit valve servicing.

G. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
H. Install refrigerant piping and tubing in protective conduit where installed belowground.

I. Install refrigerant piping and tubing in rigid or flexible conduit in locations where exposed to mechanical damage.

J. Unless otherwise required by VRF HVAC system manufacturer, slope refrigerant piping and tubing as follows:

   1. Install horizontal hot-gas discharge piping and tubing with a uniform slope downward away from compressor.
   2. Install horizontal suction lines with a uniform slope downward to compressor.
   3. Install traps to entrain oil in vertical runs.
   4. Liquid lines may be installed level.

K. When brazing, remove or protect components that could be damaged by heat.

L. Before installation, clean piping, tubing, and fittings to cleanliness level required by VRF HVAC system manufacturer.

M. Joint Construction:

   1. Ream ends of tubes and remove burrs.
   2. Remove scale, slag, dirt, and debris from inside and outside of tube and fittings before assembly.

   a. Use Type BCuP (copper-phosphorus) alloy for joining copper fittings with copper tubing.
   b. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze.

1.03 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to unit to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

E. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."
1.04 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

1.05 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.

1.06 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 23 81 26
SECTION 23 8239 - UNIT HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Propeller unit heaters with electric-resistance heating coils.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.3 RELATED SECTIONS

A. Section 230553 Identification For HVAC Piping and Equipment.

1.4 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.5 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Plans, elevations, sections, and details.

2. Location and size of each field connection.

3. Details of anchorages and attachments to structure and to supported equipment.

4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of piping valves and specialties.

6. Location and arrangement of integral controls.


C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, 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. Suspended ceiling components.

2. Structural members to which unit heaters will be attached.

3. Method of attaching hangers to building structure.

4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:
   a. Lighting fixtures.
   b. Air outlets and inlets.
   c. Speakers.
   d. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
PART 2 - PRODUCTS

2.1 PROPELLER UNIT HEATERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trane
   2. Reznor
   3. Modine
   4. Indeeco
   5. Or approved equal.

B. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

C. Comply with UL 2021.

D. Comply with UL 823.

E. Cabinet: Removable panels for maintenance access to controls.

F. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

G. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

H. Electric-Resistance Heating Elements: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant metallic sheath with fins no closer than 0.16 inch. Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.
   2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

I. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

J. Control Devices:
   1. Wall-mounting fan-speed switch.
   2. Wall-mounting thermostat.

K. Capacities and Characteristics: See schedule.
PART 3 - EXECUTION

3.1 EXAMINATION
A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.
B. Examine roughing-in for electrical connections to verify actual locations before unit heater installation.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION
A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."
B. Install propeller unit heaters level and plumb.
C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers.
D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS
A. Comply with safety requirements in UL 1995.
B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
   3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 23 8239
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Electrical equipment coordination and installation.
   2. Sleeves for raceways and cables.
   3. Sleeve seals.
   5. Common electrical installation requirements.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED SECTIONS

A. N/A

1.04 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.05 SUBMITTALS

A. Product Data: For sleeve seals.

1.5. QUALITY ASSURANCE

A. Codes and Standards:
1.06 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom
      are indicated.
   2. To provide for ease of disconnecting the equipment with minimum interference to other
      installations.
   3. To allow right of way for piping and conduit installed at required slope.
   4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of
      obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete,
   masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or
   otherwise concealed.

D. Coordinate sleeve selection and application with selection and application of firestopping.

PART 2 - PRODUCTS

2.01 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with
   plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

   a. Minimum Metal Thickness:
   b. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side
      more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm)
      and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138
      inch (3.5 mm).

2.02 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve
   and raceway or cable.

   1. Manufacturers: Subject to compliance with requirements, manufacturers offering products that
      may be incorporated into the Work include, but are not limited to, the following:
a. Advance Products & Systems, Inc.
b. Calpico, Inc.
c. Metraflex Co.
d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.

3. Pressure Plates: Stainless steel. Include two for each sealing element.

4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.03 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.02 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.
C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.03 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
3.04 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly.

3.05 SITE ENVIRONMENTAL PROCEDURES:

A. Indoor Air Quality: Temporary ventilation: Provide temporary ventilation during work and immediately after installation.

B. Energy Efficiency: Verify equipment is properly installed, connected, and adjusted. Verify that equipment is operating as specified.

1. Occupancy/Daylight Sensors: Test sensors for proper operation. Observe for light control over entire area being covered.

END OF SECTION 26 0500
SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Copper building wire rated 600 V or less.
   2. Aluminum building wire rated 600 V or less.
   3. Metal-clad cable, Type MC, rated 600 V or less.
   4. Armored cable, Type AC, rated 600 V or less.
   5. Photovoltaic cable, Type PV, rated 2000 V or less.
   6. Fire-alarm wire and cable.
   7. Connectors, splices, and terminations rated 600 V and less.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. PV: Photovoltaic.

1.05 SUBMITTALS

A. Product Data: For each type of product indicated.
1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

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. Alcan Products Corporation; Alcan Cable Division.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.

2.02 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Conductor Insulation: Type THHN and Type THWN-2: Comply with UL 83.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.
2.03 ALUMINUM BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn aluminum current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Conductor Insulation: Type THHN and Type THWN-2: Comply with UL 83.

C. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

D. Conductors: Aluminum, complying with ASTM B800 and ASTM B801.

2.04 METAL-CLAD CABLE, TYPE MC

A. Description: A factory assembly of one or more current-carrying insulated conductors in an overall metallic sheath.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. Comply with UL 1569.
   3. RoHS compliant.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits:

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Bare.

F. Conductor Insulation: Type TFN/THHN/THWN-2: Comply with UL 83.

G. Armor: Steel, interlocked.

H. Jacket: PVC applied over armor.
2.05 ARMORED CABLE, TYPE AC

A. Description: A factory assembly of insulated current-carrying conductors with or without an equipment grounding conductor in an overall metallic sheath.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   4. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Circuits: Single Circuit.

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Ground Conductor: Bare.

F. Conductor Insulation: Type THHN/THWN-2. Comply with UL 83.

G. Armor: Steel, interlocked.

2.06 PHOTOVOLTAIC CABLE, TYPE PV

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V.

B. Standards:
   1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
   2. RoHS compliant.
   3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

C. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

D. Conductor Insulation: Comply with UL 44 and UL 4703.
2.07 FIRE-ALARM WIRE AND CABLE

A. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, not less than No. 18 AWG and size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a two-hour rating.

C. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
   1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
   2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
   3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire-alarm and cable tray installation, plenum rated.

2.08 CONNECTORS AND SPLICES

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. AFC Cable Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.

C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.

D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
   1. Material: Copper.
   2. Type: Two hole with standard barrels.
   3. Termination: Compression.
PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Feeders: Copper for feeders smaller than No. 4 AWG; copper or aluminum for feeders No. 4 AWG and larger. Conductors shall be solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

D. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.


F. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.

B. All Feeders: Type THHN/THWN-2, single conductors in raceway.

C. All Branch Circuits: Type THHN/THWN-2, single conductors in raceway, Armored cable, Type AC, or Metal-clad cable, Type MC.

D. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.

E. VFC Output Circuits: Type XHHW-2 in metal conduit.

F. PV Circuits: Type PV for PV source circuits rated at 600 V.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.04 CONNECTIONS

A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 26 05 19
SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY
A. This Section includes methods and materials for grounding systems and equipment.

1.02 RELATED DOCUMENTS
A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 OWNER REQUIREMENTS
A. Owner requires no more than 25 ohms measured at any point of the grounding system.
B. All connections to ground nodes and to building steel to be exothermic.
C. Only concrete encased electrodes will be allowed for new work. If multiple electrodes all necessary, they should only be connected in series, not parallel.
D. Ground resistance tests to be performed on all ground electrodes using a testing instrument equal to AEMC Model #3710 or a fall-of-potential test.

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

1.05 QUALITY ASSURANCE
A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 CONDUCTORS

A. Insulated Conductors: Copper or tinned copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 2 inches (6 by 50 mm) in cross section, 24 inches in length, unless otherwise indicated; with insulators.

2.02 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.
1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.
PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
   1. Bury at least 24 inches (600 mm) below grade.
   2. Duct-Bank Grounding Conductor: Bury 12 inches (300 mm) above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere if indicated.
   1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

D. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
   2. Underground Connections: Welded connectors, except as otherwise indicated.
   3. Connections to Structural Steel: Welded connectors.

3.02 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 grounding requirements.

3.03 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. All feeders and branch circuits.
   2. Flexible raceway runs.
B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate 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. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode (rod) and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.04 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
   1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.
2. For grounding electrode system, install rods at locations indicated on drawings, and connect to
the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except
where routed through short lengths of conduit.
1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any
adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so
vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is
required, use a bolted clamp.

D. Grounding and Bonding for Piping:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from
building's main service equipment, or grounding bus, to main metal water service entrances to
building.  Connect grounding conductors to main metal water service pipes, using a bolted
clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts
of the flange.  Where a dielectric main water fitting is installed, connect grounding conductor on
street side of fitting.  Bond metal grounding conductor conduit or sleeve to conductor at each
end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters.
Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff
valve.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated
fans, blowers, electric heaters, and air cleaners.  Install bonding jumper to bond across flexible duct
connections to achieve continuity.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized,
test for compliance with requirements.
2. Test completed grounding system at each location where a maximum ground-resistance level is
specified, at service disconnect enclosure grounding terminal.  Make tests at ground rods before
any conductors are connected.
   a. Measure ground resistance not less than two full days after last trace of precipitation and
      without soil being moistened by any means other than natural drainage or seepage and
without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

3. Prepare dimensioned drawings locating each ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 26 0526
SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 DEFINITIONS

A. EMT: Electrical metallic tubing.
   B. IMC: Intermediate metal conduit.
   C. RMC: Rigid metal conduit.

1.05 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.
C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.06 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

B. Welding certificates.

1.07 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

1.08 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

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. GS Metals Corp.
      e. Thomas & Betts Corporation.
      f. Unistrut; Tyco International, Ltd.
      g. Wesanco, Inc.
2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

3. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel 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) MKT Fastening, LLC.
         4) 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) Empire Tool and Manufacturing Co., Inc.
         3) Hilti Inc.
         4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
         5) MKT Fastening, LLC.
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.


2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.01 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 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 (90 kg).

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: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
   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 by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

B. Field Welding: Comply with AWS D1.1/D1.1M.
3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated or 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.

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.

3.05 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 (0.05 mm).

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

END OF SECTION 26 0529
SECTION 26 0533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 DEFINITIONS

A. EMT: Electrical metallic tubing.
B. EPDM: Ethylene-propylene-diene terpolymer rubber.
C. FMC: Flexible metal conduit.
D. IMC: Intermediate metal conduit.
E. LFMC: Liquidtight flexible metal conduit.
F. NBR: Acrylonitrile-butadiene rubber.
G. RNC: Rigid nonmetallic conduit.

1.05 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 METAL CONDUIT AND TUBING

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. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   7. Maverick Tube Corporation.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
   1. Comply with NEMA RN 1.
   2. Coating Thickness: 0.040 inch (1 mm), minimum.

E. EMT: ANSI C80.3.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

H. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
   2. Fittings for EMT: Steel compression type.
   3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
I. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.02 NONMETALLIC CONDUIT AND TUBING

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. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arncor Corporation.
4. CANTEX Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; a Hubbell Company.
12. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40 or EPC-80-PVC as indicated.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.03 METAL WIREWAYS

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.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type for interior applications and Flanged-and-gasketed type for exterior applications, unless otherwise indicated.

E. Finish: Manufacturer's standard enamel finish.
2.04 **NONMETALLIC WIREWAYS**

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. Hoffman.
   2. Lamson & Sessions; Carlon Electrical Products.

B. Description: Fiberglass polyester, extruded and fabricated to size and shape indicated, with no holes or knockouts. Cover is gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections are flanged, with stainless-steel screws and oil-resistant gaskets.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.05 **BOXES, ENCLOSURES, AND CABINETS**

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 Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   7. RACO; a Hubbell Company.
   10. Spring City Electrical Manufacturing Company.

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.
I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
   1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

J. Cabinets:
   1. NEMA Type as specified on drawings.
   2. Hinged door in front cover with flush latch and concealed hinge.
   3. Key latch to match panelboards.
   4. Metal barriers to separate wiring of different systems and voltage.
   5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: IMC.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Comply with the following indoor applications, unless otherwise indicated:
   1. Exposed, Not Subject to Physical Damage: EMT.
   2. Exposed, Not Subject to Severe Physical Damage: EMT.
   3. Exposed and Subject to Severe Physical Damage: Rigid steel conduit or IMC. Includes raceways in the following locations:
      a. Mezzanines.
   4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
   5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
   6. Damp or Wet Locations: Rigid steel conduit or IMC.
   7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) trade size (except 1/2” for control cabling only where specifically indicated on the plans).

D. Raceway Fittings: Compatible with raceways and suitable for use and location.
   1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Change from ENT to RNC, Type EPC-40-PVC, rigid steel conduit, or IMC before rising above the floor.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

L. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover.
plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations.
2. Where otherwise required by NFPA 70.

M. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

N. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit for recessed and semirecessed lighting fixtures, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall.

P. Set metal floor boxes level and flush with finished floor surface.

Q. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom for pipe.
2. Install backfill.
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm)
of finished grade, make final conduit connection at end of run and complete backfilling with normal.

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

6. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried conduits, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of conduit.

### 3.04 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### 3.05 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at 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.
SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Identification for raceways.
   2. Identification of power and control cables.
   3. Identification for conductors.
   5. Warning labels and signs.
   6. Instruction signs.
   7. Equipment identification labels.
   8. Miscellaneous identification products.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.05 QUALITY ASSURANCE

A. Comply with ANSI A13.1.
B. Comply with NFPA 70.
D. Comply with ANSI Z535.4 for safety signs and labels.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.06 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

2.01 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.

2.02 METAL-CLAD CABLE IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less (MC Cable for circuits above 600V not allowed):
   1. Black letters on an orange field.
   2. Legend: Indicate voltage and system or service type.

C. 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.
2.03 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.

2.04 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.

2.05 FLOOR MARKING TAPE

A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.06 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:
   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).
   4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
   5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).
2.07 WARNING LABELS AND SIGNS


B. Baked-Enamel Warning Signs:
1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
2. 1/4-inch (6.4-mm) grommets in corners for mounting.
3. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.08 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes.
1. Engraved legend with black letters on white face.
2. Punched or drilled for mechanical fasteners.
3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch (10 mm). Overlay shall provide a weatherproof and UV-resistant seal for label.

2.09 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch (25 mm)

2.010 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).

C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 7000 psi (48.2 MPa).
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F (Minus 46 to plus 140 deg C).
5. Color: Black.

2.011 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

3.01 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. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.

H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.
2. In Spaces Handling Environmental Air: Plenum rated.
I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches above duct. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

J. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.02 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 20A, and 120V to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot (10-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
   1. Power.
   2. Lighting.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, and handholes, use color-coding conductor tape to identify the phase.
   1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
      a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
      b. Colors for 208/120-V Circuits:
         1) Phase A: Black.
         2) Phase B: Red.
         3) Phase C: Blue.
      c. 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.

D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
   1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
   2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
   1. Limit use of underground-line warning tape to direct-buried cables.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
   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.

J. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.

K. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer and load shedding.

L. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
   1. Labeling Instructions:
      a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (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: Stenciled legend 4 inches (100 mm) high.
      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 contractor. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
b. Enclosures and electrical cabinets.
c. Access doors and panels for concealed electrical items.
d. Enclosed switches.
e. Enclosed circuit breakers.
f. Enclosed controllers.
g. Push-button stations.
h. Power transfer equipment.
i. Contactors.
j. Remote-controlled switches, dimmer modules, and control devices.
k. Power-generating units.
l. Monitoring and control equipment.

END OF SECTION 26 05 53
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Distribution panelboards.
   2. Lighting and appliance branch-circuit panelboards.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 DEFINITIONS

A. SVR: Suppressed voltage rating.

1.05 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, SPD, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each panelboard and related equipment.
   1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
   2. Detail enclosure types and details for types other than NEMA 250, Type 1.
   3. Detail bus configuration, current, and voltage ratings.
   4. Short-circuit current rating of panelboards and overcurrent protective devices.
   5. Include evidence of NRTL listing for series rating of installed devices.
6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

7. Include wiring diagrams for power, signal, and control wiring.

C. Field Quality-Control Reports:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

E. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NEMA PB 1.

D. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407.

1.08 PROJECT CONDITIONS

A. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   a. Ambient Temperature: Not exceeding 23 deg F (minus 5 deg C) to plus 104 deg F (plus 40 deg C).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

1.09 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.

1.010 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace power monitoring devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Five years from date of Substantial Completion.

1.011 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard, in addition to spare breakers indicated to be installed within panelboard.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Surface mounted cabinets.
   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.
2. Front: Secured to box with concealed trim clamps. Match box dimensions.

3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.

4. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.

5. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.

6. Finishes:
   a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
   c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.


B. Incoming Mains Location: Top / bottom as required.

C. Phase, Neutral, and Ground Buses:
   1. Material: Copper.
   2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

D. Conductor Connectors: Suitable for use with conductor material and sizes.
   1. Material: Copper.
   2. Main and Neutral Lugs: Compression type.
   3. Ground Lugs and Bus-Configured Terminators: Compression type.
   4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.

F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

2.02 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Square D.
   2. Eaton.
   3. Siemens.
   4. GE.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
   1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Mains: Main Circuit Breaker or Main Lugs only, as indicated on drawings.

E. Branch Overcurrent Protective Devices: Bolt-on circuit breakers.

2.03 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Square D.
   2. Eaton.
   3. Siemens.
   4. GE.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only, as indicated on drawings.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Narrow gutter extension, with cover, to overhead junction box equipped with ground and neutral terminal buses.
2.04 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Equipment Mounting: Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

E. Mount panelboard cabinet plumb and rigid without distortion of box.

F. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch empty conduits from any recessed panelboard into accessible ceiling space or space designated to be ceiling space in the future.

I. Comply with NECA 1.
3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. Tests and Inspections:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
B. Set field-adjustable circuit-breaker trip ranges. Circuit changes made during load balancing may negate color-coding of phases and circuits. If load balancing proves undesirable or is to be performed by others, delete paragraph below.

3.06 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION 26 2416
SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Receptacles, receptacles with integral GFCI, and associated device plates.
   2. Snap switches.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 DEFINITIONS

A. GFCI: Ground-fault circuit interrupter.

B. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

1.05 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For wiring devices to include in all manufacturers’ packing label warnings and instruction manuals that include labeling conditions.

1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NFPA 70.

1.07 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
   2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   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. Cooper; 5352 (white, duplex).
      b. Hubbell; HBL5352 (white, duplex).
      c. Leviton; 5352 (white, duplex).
      d. Pass & Seymour; 5352 (white, duplex).

2.03 GFCI RECEPTACLES

A. General Description: Straight blade, feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
   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. Cooper; VGF20, white.
      b. Pass & Seymour; 2095, white.

2.04 SNAP SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   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. Cooper; 2221 (single pole).
b. Hubbell; CS1221 (single pole).
c. Leviton; 1221-2 (single pole).
d. Pass & Seymour; 20AC1 (single pole).

2.05 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces (except kitchen area and Apparatus Bay): Thermoplastic, color to match the wall color or as directed by architect.
   4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

C. For receptacle wall plates, identify each with adhesive label indicating circuit name and breaker number.

2.06 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. General Wiring Devices: White, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to ensure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.
   2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
   3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
   4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:
   1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

D. Device Installation:
1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.

F. Device Plates:
Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening. Identify device plates for all receptacles with adhesive label indicating panel name and circuit breaker number.

G. Arrangement of Devices:
Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.02 IDENTIFICATION
A. Comply with Division 26 Section "Identification for Electrical Systems."

3.03 FIELD QUALITY CONTROL
A. Perform tests and inspections and prepare test reports.
1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
SECTION 26 2816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Nonfusible switches.
   2. Enclosed circuit breakers.
   3. Enclosures.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. N/A

1.04 DEFINITIONS

A. NC: Normally closed.
B. NO: Normally open.
C. SPDT: Single pole, double throw.

1.05 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
   1. Enclosure types and details for types other than NEMA 250, Type 1.
   2. Current and voltage ratings.
   3. Short-circuit current ratings (interrupting and withstand, as appropriate).
   4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
1.06 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

1.07 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
   1. Ambient Temperature: Not less than minus 22 deg F (minus 30 deg C) and not exceeding 115 deg F.

1.08 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.01 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Compression type, suitable for number, size, and conductor material.

2.02 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.


D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

F. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.

2.03 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
   1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
   2. Outdoor Locations: NEMA 250, Type 3R.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.01 EXAMINATION
   A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
   B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION
   A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
   B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
   C. Comply with NECA 1.

3.03 IDENTIFICATION
   A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
      1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
      2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL
   A. Perform tests and inspections.
      1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   B. Acceptance Testing Preparation:
      1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
      2. Test continuity of each circuit.
   C. Tests and Inspections:
1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Perform the following infrared scan tests and inspections and prepare reports:
   a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
   b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

END OF SECTION 26 2816
SECTION 26 31 00 - PHOTOVOLTAIC COLLECTORS

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 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.3 SUMMARY

A. Section Includes:

1. PV Modules.
2. Inverters.
3. Mounting structures.

1.4 CONTRACTOR QUALIFICATIONS

A. The contractor shall have been in business for a minimum of 3 years

B. The contractor shall have on staff a minimum of 3 (three) NABCEP Certified PV Installers and shall have a NABCEP Certified PV Installer as project manager on this installation. Copies of these certificates shall be provided with the proposal.

C. The contractor shall demonstrate experience with 3 municipal customers by providing project details with their proposal, including system size, technology, mounting as well as a customer contact email and phone number. At least one of these projects should be a solar installation project.

D. The contractor shall hold a valid Texas Electrical Contractor’s License and provide a copy with the proposal.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for PV panels.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For PV modules.
   1. Include plans, elevations, sections, and mounting details.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Detail fabrication and assembly.
   4. Include diagrams for power, signal, and control wiring.

1.6 INFORMATIONAL SUBMITTALS
   A. Field quality-control reports.
   B. Sample Warranty: For manufacturer's special materials and workmanship warranty and minimum power output warranty.

1.7 CLOSEOUT SUBMITTALS
   A. Operation and Maintenance Data: For PV modules to include in operation and maintenance manuals.

1.8 WARRANTY
   A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace components of PV modules that fail in materials or workmanship within specified warranty period.
      1. Warranty Period: Five years from date of Substantial Completion.
   B. Manufacturer's Special Minimum Power Output Warranty: Manufacturer agrees to repair or replace components of PV modules that fail to exhibit the minimum power output within specified warranty period. Special warranty, applying to modules only, applies to materials only, on a prorated basis, for period specified.
      1. Manufacturer's minimum power output warranties include, but are not limited to, the following warranty periods, from date of Substantial Completion:
         a. Specified minimum power output to 80 percent or more, for a period of 25 years.

PART 2 - PRODUCTS

2.1 SOLAR MODULES
   A. Manufacturers:
      1. LG. Model: LG400N2W-V5
2. Substitutions: Permitted with approval from engineer or architect. Contractor is responsible for any engineering or architectural changes related to substitutions. Modules must meet the following certifications and criteria:
   a. Modules must be certified to UL 1703 – “Flat-Plate Photovoltaic Modules and Panels”.
   b. ANSI Z23.83 (solar PV performance and safety).
   c. NEPA 70 (electrical components)
   d. Fit in the same boundaries as the specified module.
   e. Have an output tolerance not greater than +10%/-5%.
   f. Produce the same amount of energy in the same boundaries the specified panels are shown contained within on plans. Boundaries follow 2015 IFC 605.11 and shading on Dec. 21st. See plans for energy outputs.
3. PV Modules shall have a 25 year linear power output warranty guaranteeing no less than 90% degradation in year 10 and 80% degradation in year 25.
4. Warranty: 5 year material and workmanship warranty.

2.2 INVERTERS

A. Manufacturers:
   2. Substitutions: Permitted with approval from architect. Contractor is responsible for any engineering or architectural changes related to substitutions. Inverters must meet the following certifications and criteria:
      b. UL 1741 – “Standard for Static Inverters and Charge Controllers for use in Photovoltaic Systems”.
      c. FCC part 15.
      d. Micro-inverter required for constant array shading needs.
      e. Compatible with solar module.

2.3 MOUNTING STRUCTURES

A. Roof Mount: Standing seam mounting system.

PART 3 - EXECUTION

3.1 EXAMINATION

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

B. Do not begin installation until mounting surfaces have been properly prepared.

C. If preparation of mounting surfaces is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
D. Examine modules and array frame before installation. Reject modules and arrays that are wet, moisture damaged, or mold damaged.

E. Examine roofs, supports, and supporting structures for suitable conditions where PV system will be installed.

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

**3.2 INSTALLATION**

A. Comply with NECA 1.

B. Coordinate layout and installation of PV panels with roof assembly and other construction.

C. Support PV panel assemblies independent of supports for other elements such as roof and support assemblies, enclosures, vents, pipes, and conduits. Support assembly to prevent twisting from eccentric loading.

D. Install PV modules, inverters, disconnects, and rapid shutdown in locations indicated on Drawings.

E. Wiring Method: Install cables in raceways.

F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

**3.3 CONNECTIONS**

A. Coordinate PV panel cabling to equipment enclosures to ensure proper connections.

B. Coordinate installation of utility-interactive meter with utility.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Make splices, terminations, and taps that are compatible with conductor material.

END OF SECTION 26 3100
SECTION 263213 - GASEOUS ENGINE GENERATORS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. LP gas engine.
   2. Control and monitoring.
   3. Generator overcurrent and fault protection.
   4. Generator, exciter, and voltage regulator.
   5. Outdoor generator-set enclosure.

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED SECTIONS

A. Section 26 3600 – Automatic Transfer Switches

1.04 DEFINITIONS

A. LP: Liquefied petroleum.

B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product.
   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Include thermal damage curve for generator.
   3. Include time-current characteristic curves for generator protective device.
   4. Include fuel consumption in cubic feet per hour (cubic meters per hour) at 0.8 power factor at 0.5, 0.75 and 1.0 times generator capacity.
   5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
   6. Include air flow requirements for cooling and combustion air in cfm at 0.8 power factor, with air supply temperature of 95 deg F (35 deg C), 80 deg F (27 deg C), 70 deg F (21 deg C), and 50
deg F (10 deg C). Provide drawings showing requirements and limitations for location of air intake and exhausts.

7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. **Shop Drawings:**
   1. Include plans and elevations for engine generator and other components specified.
   2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   3. Identify fluid drain ports and clearance requirements for proper fluid drain.
   4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
   6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for EPS equipment and functional relationship between all electrical components.

C. **Testing Reports:**
   1. Include testing reports as required submittals per Field Quality Control notes.

1.06 **INFORMATIONAL SUBMITTALS**

A. Source Quality-Control Reports: Including, but not limited to, the following:
   1. Certified summary of prototype-unit test report.
   2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
   4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
   6. Report of exhaust emissions showing compliance with applicable regulations.

B. Field quality-control reports.

C. Warranty: For special warranty.

1.07 **CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For engine generators to include in emergency, operation, and maintenance manuals.
   1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
      a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
b. Operating instructions laminated and mounted adjacent to generator location.
c. Training plan.

1.08 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
   2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
   3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
   4. Tools: Each tool listed by part number in operations and maintenance manual.

1.09 QUALITY ASSURANCE

A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: Accredited by NETA.
   1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

1.010 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

1.01 MANUFACTURERS

A. Manufacturers: Provide product by one of the following:
   1. Cummins
   2. Kohler
   3. Caterpillar
   4. Stewart and Stevenson

B. Source Limitations: Obtain packaged engine generators and auxiliary components through one source from a single manufacturer.

1.02 PERFORMANCE REQUIREMENTS

A. B11 Compliance: Comply with B11.19.

B. NFPA Compliance:
   2. Comply with NFPA 70.
C. UL Compliance: Comply with UL 2200.

D. Engine Exhaust Emissions: Comply with EPA Tier 4 requirements and applicable state and local government requirements.

E. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by engine generator including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.03 ENGINE GENERATOR ASSEMBLY DESCRIPTION

A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency acceptable to authorities having jurisdiction, and marked for intended location and use.

C. Power Rating: Standby.

D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.

E. Service Load: 80 kVA.

F. Power Factor: 0.8, lagging.

G. Frequency: 60 Hz.

H. Voltage: 240 V ac.

I. Phase: Single-phase, three wire.

J. Induction Method: Naturally aspirated or Turbocharged.

K. Governor: Adjustable isochronous, with speed sensing.

L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
   1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and generator-set center of gravity.

M. Capacities and Characteristics:
   1. Power Output Ratings: Nominal ratings as indicated at 0.8 power factor excluding power required for the continued and repeated operation of the unit and auxiliaries.
   2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.

N. Engine Generator Performance:
1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
8. Start Time: 10 seconds.

1.04 GASEOUS ENGINE

A. Fuel: LP gas.

B. Rated Engine Speed: 1800 rpm.

C. Lubrication System: Engine or skid-mounted.
   1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
   2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
   3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.


E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator mounting frame and integral engine-driven coolant pump.
   1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

   a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
   b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

F. Cooling System: Closed loop, liquid cooled, with remote radiator and integral engine-driven coolant pump. Comply with requirements in Section 232113 "Hydronic Piping" for coolant piping.
   2. Radiator Core Tubes: Aluminum.
   3. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
   4. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
   5. Fan: Driven by totally enclosed electric motor with sealed bearings.
   6. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
   7. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

G. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
   1. Minimum sound attenuation of 25 dB at 500 Hz.
   2. Sound level measured at a distance of 25 feet (8 m) from exhaust discharge after installation is complete shall be 78 dBA or less.


I. Starting System: 12-V electric, with negative ground.
   1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
   2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
   4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least twice without recharging.
   5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
   6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50
deg F (10 deg C) regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.

7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.


9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
   a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
   b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg F (minus 40 deg C) to 140 deg F (plus 60 deg C) to prevent overcharging at high temperatures and undercharging at low temperatures.
   c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
   e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
   f. Enclosure and Mounting: NEMA 250, Type 3R, wall-mounted cabinet.

1.05 GASEOUS FUEL SYSTEM

A. Gas Train: Comply with NFPA 37.

B. Engine Fuel System: Dual Fuel

C. LP Gas, Vapor-Withdrawal System:
   1. Carburetor.
   2. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
   3. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
   4. Fuel Filters: One for each fuel type.
   6. Flexible Fuel Connectors: Minimum one for each fuel connection.
   7. LP gas flow adjusting valve.
1.06 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates generator-set shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.

C. Provide minimum run time control set for 15 minutes with override only by operation of a remote emergency-stop switch.

D. Comply with UL 508A.

E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from generator-set vibration. Panel shall be powered from the engine generator battery.

F. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common wall-mounted control and monitoring panel. Panel shall be powered from the engine generator battery.

G. Configuration: Operating and safety indications, protective devices, basic system controls, engine gages, instrument transformers, generator disconnect switch or circuit breaker, and other indicated components shall be grouped in a combination control and power panel. Control and monitoring section of panel shall be isolated from power sections by steel barriers. Panel shall be powered from the engine generator battery. Panel features shall include the following:
   2. Switchboard Construction: Freestanding unit complying with Section 262413 "Switchboards." Power bus shall be copper. Bus, bus supports, control wiring, and temperature rise shall comply with UL 891.
   3. Switchgear Construction: Freestanding unit complying with Section 262300 "Low-Voltage Switchgear."

H. Control and Monitoring Panel:
   1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
   2. Analog control panel with dedicated gages and indicator lights for the instruments and alarms indicated below.
   3. Instruments: Located on the control and monitoring panel and viewable during operation.
a. Engine lubricating-oil pressure gage.
b. Engine-coolant temperature gage.
c. DC voltmeter (alternator battery charging).
d. Running-time meter.
e. AC voltmeter, for each phase.
f. AC ammeter, for each phase.
g. AC frequency meter.
h. Generator-voltage adjusting rheostat.

4. Controls and Protective Devices: Controls, shutdown devices, and common visual alarm indication, including the following:
   a. Cranking control equipment.
   c. Control switch not in automatic position alarm.
   d. Overcrank alarm.
   e. Overcrank shutdown device.
   f. Low water temperature alarm.
   g. High engine temperature prealarm.
   h. High engine temperature.
   i. High engine temperature shutdown device.
   j. Overspeed alarm.
   k. Overspeed shutdown device.
   l. Low fuel main tank.
   m. Coolant low-level alarm.
   n. Coolant low-level shutdown device.
   o. Coolant high-temperature prealarm.
   p. Coolant high-temperature alarm.
   q. Coolant low-temperature alarm.
   r. Coolant high-temperature shutdown device.
   s. EPS supplying load indicator.
   t. Battery high-voltage alarm.
   u. Low cranking voltage alarm.
   v. Battery-charger malfunction alarm.
   w. Battery low-voltage alarm.
   x. Lamp test.
   y. Contacts for local and remote common alarm.
   z. Low-starting air pressure alarm.
   aa. Low-starting hydraulic pressure alarm.
   bb. Remote manual stop shutdown device.
   cc. Air shutdown damper alarm when used.
   dd. Air shutdown damper shutdown device when used.
   ee. Hours of operation.
   ff. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
   gg. Generator overcurrent protective device not closed alarm.

I. Common Remote Panel with Common Audible Alarm: Include necessary contacts and terminals in control and monitoring panel. Remote panel shall be powered from the engine generator battery.
J. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
1. Overcrank alarm.
2. Coolant low-temperature alarm.
3. High engine temperature prealarm.
4. High engine temperature alarm.
5. Low lube oil pressure alarm.
6. Overspeed alarm.
7. Low fuel main tank alarm.
8. Low coolant level alarm.
9. Low cranking voltage alarm.
10. Contacts for local and remote common alarm.
12. Air shutdown damper when used.
14. Control switch not in automatic position alarm.
15. Fuel tank derangement alarm.
16. Fuel tank high-level shutdown of fuel supply alarm.
17. Lamp test.
18. Low cranking voltage alarm.
19. Generator overcurrent protective device not closed.

K. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

L. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

1.07 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; complying with UL 489.
1. Tripping Characteristic: Designed specifically for generator protection.
2. Trip Rating: Matched to generator output rating.
3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a
shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector performs the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms. Contacts shall be available for load shed functions.

2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.

3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the engine generator.

4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

1.08 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide six lead alternator.

E. Range: Provide limited range of output voltage by adjusting the excitation level.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter.

1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.

2. Maintain voltage within 20 percent on one step, full load.

3. Provide anti-hunt provision to stabilize voltage.

4. Maintain frequency within 10 percent and stabilize at rated frequency within 5 seconds.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.
1.09 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
   1. Sound Attenuation Level: II.

B. Description: Prefabricated or pre-engineered galvanized-steel-clad, integral structural-steel-framed, walk-in enclosure, erected on concrete foundation.

C. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph (160 km/h).

D. Hinged Doors: With padlocking provisions.

E. Space Heater: Thermostatically controlled and sized to prevent condensation.

F. Lighting: Provide weather-resistant LED lighting with 30 fc (330 lux) average maintained.

G. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.

H. Muffler Location: External to enclosure.

I. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.
   1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
   2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.
   3. Ventilation: Provide temperature-controlled exhaust fan interlocked to prevent operation when engine is running.

J. Interior Lights with Switch: Factory-wired, vapor-proof fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.
   1. AC lighting system and connection point for operation when remote source is available.
   2. DC lighting system for operation when remote source and generator are both unavailable.

K. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

1.010 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.

2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.

3. Minimum Additional Travel: 50 percent of required deflection at rated load.

4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

6. Minimum Deflection: 1 inch (25 mm).

B. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

1.011 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

1.012 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.


B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.

2. Test generator, exciter, and voltage regulator as a unit.

3. Full load run.

4. Maximum power.

5. Voltage regulation.

6. Transient and steady-state governing.


8. Safety shutdown.

9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.

10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

1.01 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

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

1.02 INSTALLATION

A. Comply with NECA 1 and NECA 404.

B. Comply with packaged engine generator manufacturers' written installation.

C. Equipment Mounting:
   1. Coordinate reinforced concrete pad for generator with Division 03
   2. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
   3. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
   4. Install engine generator in a walk-in enclosure with restrained spring isolators having a minimum deflection of [1 inch (25 mm)] <Insert static deflection> on 4-inch- (100-mm-) high concrete base. Secure enclosure to anchor bolts installed in concrete bases. Concrete base construction is specified in Section 260548.16 "Seismic Controls for Electrical Systems."

D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

E. Cooling System: Install Schedule 40, black steel piping with welded joints for cooling water piping between engine generator and heat exchanger. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
   1. Install isolating thimbles where exhaust piping penetrates combustible surfaces. Provide a minimum of 9 inches (225 mm) clearance from combustibles.
   2. Insulate cooling system piping and components according to requirements in Section 230719 "HVAC Piping Insulation."

F. Exhaust System: Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet.
   1. Install flexible connectors and steel piping materials according to requirements in Section 232116 "Hydronic Piping Specialties."
   2. Insulate muffler/silencer and exhaust system components according to requirements in Section 230719 "HVAC Piping Insulation."
   3. Install isolating thimbles where exhaust piping penetrates combustible surfaces with a minimum of 9-inch (225-mm) clearance from combustibles.
G. **Drain Piping:** Install condensate drain piping to muffler drain outlet with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe, the full size of the drain connection, with welded joints.

H. **Gaseous Fuel Piping:**
   1. Natural gas piping, valves, and specialties for gas distribution are specified in Section 231123 "Facility Natural Gas Piping."
   2. LP gas piping, valves, and specialties for gas piping are specified in Section 231126 "Facility Liquefied-Petroleum Gas Piping."

I. **Electrical Wiring:** Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1.03 **CONNECTIONS**

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect cooling-system water piping to engine generator and [remote radiator] [heat exchanger] with flexible connectors.

D. Connect engine exhaust pipe to engine with flexible connector.

E. **Gaseous Fuel Connections:**
   1. Connect fuel piping to engines with a gate valve and union and flexible connector.
   2. Install manual shutoff valve in a remote location to isolate gaseous fuel supply to the generator.
   3. Vent gas pressure regulators outside building a minimum of 60 inches (1500 mm) from building openings.

F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
   Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.

H. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

1.04 **IDENTIFICATION**

A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

B. Install a sign indicating the generator neutral is bonded to the main service neutral at the main service location.
1.05 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections with the assistance of a factory-authorized service representative.

D. Tests and Inspections:
1. Testing shall be in compliance with NFPA 110 acceptance testing requirements, including duration and loading.
2. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in the first two subparagraphs below as specified in the NETA ATS. Certify compliance with test parameters.
   a. Visual and Mechanical Inspection
      1) Compare equipment nameplate data with drawings and specifications.
      2) Inspect physical and mechanical condition.
      3) Inspect anchorage, alignment, and grounding.
      4) Verify the unit is clean.
   b. Electrical and Mechanical Tests
      1) Perform insulation-resistance tests in accordance with IEEE 43.
         a) Machines larger than 200 hp (150 kW). Test duration shall be 10 minutes. Calculate polarization index.
         b) Machines 200 hp (150 kW) or less. Test duration shall be one minute. Calculate the dielectric-absorption ratio.
      2) Test protective relay devices.
      3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      5) Perform vibration test for each main bearing cap.
      6) Verify correct functioning of the governor and regulator.
3. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
   a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
   b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
   c. Verify acceptance of charge for each element of the battery after discharge.
   d. Verify that measurements are within manufacturer's specifications.
4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.

7. Exhaust Emissions Test: Comply with applicable government test criteria.

8. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

9. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 percent and 100 percent of rated linear load. Verify that harmonic content is within specified limits.

10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet (8 m) from edge of the generator enclosure, and compare measured levels with required values.

E. Coordinate tests with tests for transfer switches and run them concurrently.

F. Test instruments shall have been calibrated within the last 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.

G. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.

H. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.

I. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

J. Remove and replace malfunctioning units and [retest] [reinspect] as specified above.

K. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

L. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

M. Infrared Scanning: After Substantial Completion, but not more than 60 days after final acceptance, perform an infrared scan of each power wiring termination and each bus connection while running with maximum load. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

1.06 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators.

END OF SECTION 26 3213
SECTION 26 3600 – AUTOMATIC TRANSFER SWITCHES

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 RELATED REQUIREMENTS

A. 263213 - Gaseous Engine Generators

1.04 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.
   1. Technical data on all major components of all transfer switches and other products described in this section. Data is required for the transfer switch mechanism, control system, cabinet, and protective devices specifically listed for use with each transfer switch. Include steady state and fault current ratings, weights, operating characteristics, and furnished specialties and accessories.
   2. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   1. Dimensioned outline drawings of assembly, including elevations, sections, and details including minimal clearances, conductor entry provisions, gutter space, installed features and devices and material lists for each switch specified.
   2. Internal electrical wiring and control drawings.
   3. Interconnection wiring diagrams, showing recommended conduit runs and point-to-point terminal connections to generator set.
   4. Installation and mounting instructions, including information for proper installation of equipment to meet seismic requirements.
C. Manufacturer and Supplier Qualification Data
   1. The transfer switch manufacturer shall be certified to ISO 9001 International Quality Standard and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.
   2. The manufacturer of this equipment shall have produced similar equipment for a minimum period of 10 years. When requested, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays, timers and protective devices; provide setting and calibration instructions where applicable.

E. Warranty documents demonstrating compliance with the project’s contract requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Submit names, experience level, training certifications, and locations for technicians that will be responsible for servicing equipment at this site.
   2. The manufacturer shall maintain model and serial number records of each transfer switch provided for at least 20 years.

B. Source Limitations: All transfer switches are to be obtained through one source from a single manufacturer. The generator set manufacturer shall warrant transfer switches to provide a single source of responsibility for products provided.

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 as suitable for use in emergency, legally required or optional standby use as appropriate for the connected load.

D. The automatic transfer switch installation and application shall conform to the requirements of the following codes and standards:
   1. Transfer switches and enclosures shall be UL 1008 listed and labeled as suitable for use in emergency, legally required, and optional standby applications.
   3. NFPA 70, National Electrical Code. Equipment shall be suitable for use in systems in compliance with Articles 700, 701 and 702.
   4. Comply with NEMA ICS 10-1993 AC Automatic Transfer Switches
   5. IBC 2006 – The transfer switch(es) shall be prototype-tested and third-party certified to comply with the requirements of IBC group III or IV, Category D/F. The equipment shall be shipped with the installation instructions necessary to attain installation compliance
   6. IEEE 446 – Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications
7. EN55011, Class B Radiated Emissions and Class B Conducted Emissions  
8. IEC 1000-4-5 (EN 61000-4-5); AC Surge Immunity  
9. IEC 1000-4-4 (EN 61000-4-4) Fast Transients Immunity  
10. IEC 1000-4-2 (EN 61000-4-2) Electrostatic Discharge Immunity  
11. IEC 1000-4-3 (EN 61000-4-3) Radiated Field Immunity  
12. IEC 1000-4-6 Conducted Field Immunity  
13. IEEE 62.41, AC Voltage Surge Immunity  
14. IEEE 62.45, AC Voltage Surge Testing  

E. Comply with NFPA 110 – Emergency and Standby Power Systems. The transfer switch shall meet all requirements for Level 1 systems, regardless of the actual circuit level.  

F. The manufacturer shall warrant the material and workmanship of the transfer switch equipment for a minimum of two (2) years from date of Substantial Completion.  

G. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, and etc. during the minimum noted warranty period described above.  

PART 2 - PRODUCTS  

2.01 MANUFACTURERS  

A. Manufacturers: Must be provided by generator manufacturer.  

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS  

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer.  

B. Fault-Current Closing and Withstand Ratings: UL 1008 WCR ratings must be specifically listed as meeting the requirements for use with protective devices at installation locations, under specified fault conditions.  

C. Solid-State Controls: All settings should be accurate to +/- 2% or better over an operating temperature range of -40 to +60 degrees C (-40 to +140 degrees F).  

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.  

E. Electrical Operation: Accomplished by a non-fused, momentarily energized solenoid or electric motor operator mechanism, mechanically and electrically interlocked in both directions.  

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Switches using molded-case switches or circuit breakers, or insulated case circuit breaker components are not acceptable.
2. Transfer switches shall be double-throw, electrically and mechanically interlocked, and mechanically held in the Source 1 and Source 2 positions.
3. Main switch contacts shall be high-pressure silver alloy. Contact assemblies shall have arc chutes for positive arc extinguishing. Arc chutes shall have insulating covers to prevent inter-phase flashover.
4. Contacts shall be operated by a high-speed electrical mechanism that causes contacts to open or close within three electrical cycles from signal.
5. The transfer switch operation shall include the ability to switch to an open position (both sources disconnected) for the purpose of load shedding from the generator set.
6. The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.
7. Transfer switch shall be provided with flame retardant transparent covers to allow viewing of switch contact operation but prevent direct contact with components that could be operating at line voltage levels.
8. The transfer switch shall include the mechanical and control provisions necessary to allow the device to be field-configured for operating speed. Transfer switch operation with motor loads shall be as is recommended in NEMA MG1.
a. Phase angle monitoring/timing equipment is not an acceptable substitute for this functionality

G. Neutral Switching: Switches must be provided with switched neutral (neutral pole switched simultaneously with phase poles). 4- pole as indicated on drawings.

H. Control: Transfer switch control shall be capable of communicating with the genset control, other switches and remote programming devices over a high-speed network interface.

I. Factory wiring: Transfer switch internal wiring shall be composed of pre-manufactured harnesses that are permanently marked for source and destination. Harnesses shall be connected to the control system by means of locking disconnect plug(s), to allow the control system to be easily disconnected and serviced without disconnecting power from the transfer switch mechanism.

J. Terminals: Terminals shall be pressure type and appropriate for all field wiring. Terminal arrangement and cabinet space must be such that feeder conductors can enter from the top, side or bottom of the switch, at the installer’s discretion. Control wiring shall be equipped with suitable lugs, for connection to terminal strips.

K. Enclosures: All enclosures shall be third-party certified for compliance to NEMA ICS 6 and UL 508, unless otherwise indicated:
1. The enclosure shall provide wire bend space in compliance to the latest version of NFPA70, regardless of the direction from which the conduit enters the enclosure.
2. Exterior cabinet doors shall provide complete protection for the system’s internal components. Doors must have permanently mounted key-type latches. Bolted covers or doors are not acceptable.
3. Transfer switches shall be supplied in NEMA Type 3R (IEC IP34).

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Indicated current ratings:
   1. Refer to the Project drawings for specifications on the sizes and types of transfer switch equipment, withstand and closing ratings, number of poles, voltage and ampere ratings, enclosure type, and accessories.
   2. Main contacts shall be rated for 600 VAC minimum.
   3. Transfer switches shall be rated to carry 100% of rated current continuously in the enclosure supplied, in ambient temperatures of -40 to +60 degrees C (-40 to +140 degrees F), relative humidity up to 95% (non-condensing), and altitudes up to 10,000 feet (3000 meters).

C. Manual Switch Operation: The power transfer mechanism shall include provisions for manual operation under load with the enclosure door closed. Manual operation may be electromechanical or mechanical, but must be coordinated with control function.

D. Control: Transfer switch control shall be capable of communicating with the genset control and remote programming devices.

E. Neutral Switching: Transfer switches shall be provided with a switched neutral pole. The neutral pole shall be of the same construction and have the same ratings as the phase poles. All poles shall be switched simultaneously using a common crossbar. Substitute equipment using overlapping neutral contacts is not acceptable.

F. Automatic Transfer Switch Control Features
   1. The transfer switch control system shall be configurable in the field for any operating voltage level up to 600 VAC. Voltage sensing shall be monitored based on the normal voltage at the site. Systems that utilize voltage monitoring based on standard voltage conditions that are not field configurable are not acceptable.
   2. All transfer switch sensing shall be configurable from an operator panel or from a Windows XP or later PC-based service tool. Designs utilizing DIP switches or other electromechanical devices are not acceptable.
   3. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device for load shedding purposes. On receipt of this signal, the transfer switch shall switch to a neutral position when connected to Source 2. If Source 1 is available when the load-shed signal is received, the transfer switch shall connect to Source 1.
   4. The transfer switch shall be configurable to accept a relay contact signal and a network signal from an external device to prevent transfer to the generator service.
   5. The transfer switch shall provide a relay contact signal prior to transfer or re-transfer. The time period before and after transfer shall be adjustable in a range of 0 to 50 seconds.
   6. The control system shall be designed and prototype tested for operation in ambient temperatures from -40 degrees C to +60 degrees C (-40 to +140 degrees F). It shall be designed and tested to comply with the requirements of the noted voltage and RFI/EMI standards.
7. The control shall have optically isolated logic inputs, high isolation transformers for AC inputs and relays on all outputs, to provide optimum protection from line voltage surges, RFI and EMI.

8. The transfer switch network monitoring equipment, when supplied, shall be provided with a battery-based auxiliary power supply to allow monitoring of the transfer switch when both AC power sources are non-operational. The battery power supply shall be monitored for proper condition, and the transfer switch shall include an alarm condition to indicate low battery condition.

G. Transfer Switch Control Panel: The transfer switch shall have a microprocessor-based control with a sealed membrane panel incorporating pushbuttons for operator-controlled functions, and LED lamps for system status indicators. The panel shall also include an alphanumeric display for detailed system information. Panel display and indicating lamps shall include permanent labels.

1. The indicator panel LEDs shall display:
   a. Which source the load is connected to (Source 1 or Source 2)
   b. Which source or sources are available
   c. When switch is not set for automatic operation, because the control is disabled or the bypass switch is in use
   d. When the switch is in test/exercise mode

2. The indicator shall have pushbuttons that allow the operator to activate the following functions:
   a. Activate pre-programmed test sequence
   b. Override programmed delays, and immediately go to the next operation
   c. Reset the control by clearing any faults
   d. Test all of the LEDs by lighting them simultaneously

3. The alphanumeric digital display shall be vacuum fluorescent-type, clearly visible in both bright sunlight and no-light conditions over an angle of 120 degrees, and shall display the following:
   a. AC voltage for all phases, normal and emergency
   b. Source status: connected or not connected.
   c. Load data, including voltage, AC current, frequency, KW, KVA, and power factor.

4. The display panel shall be password-protected, and allow the operator to view and make adjustments:
   a. Set nominal voltage and frequency for the transfer switch
   b. Adjust voltage and frequency sensor operation set points
   c. Set up time clock functions
   d. Set up load sequence functions
   e. Enable or disable control functions including program transition
   f. View real-time clock data, operation log (hours connected, times transferred, failures) and service history

H. Control Functions: Functions managed by the control shall include:

1. Software adjustable time delays:
   a. Engine start (prevents nuisance genset starts in the event of momentary power fluctuation): 0 to 120 seconds (default 3 sec)
   b. Transfer normal to emergency (allows genset to stabilize before load is transferred): 0 to 120 seconds (default 3 sec)
   c. Re-transfer emergency to normal (allows utility to stabilize before load is transferred from genset): 0 to 30 minutes (default 3 sec)
d. Engine cooldown: 0 to 30 minutes (default 10 min)
   e. Programmed transition: 0 to 60 seconds (default 3 sec)

2. Undervoltage sensing: three-phase normal, three-phase emergency source.
   a. Pickup: 85 to 98% of nominal voltage (default 90%)
   b. Dropout: 75 to 98% of nominal voltage (default 90%)
   c. Dropout time delay: 0.1 to 1.0 seconds (default 0.5 sec)
   d. Accurate to within +/- 1% of nominal voltage

3. Over-voltage sensing: three-phase normal, three-phase emergency source.
   a. Pickup: 95 to 99% of dropout setting (default 95%)
   b. Dropout: 105 to 135% of nominal voltage (default 110%)
   c. Dropout time delay: 0.5 to 120 seconds (default 3 sec)
   d. Accurate to within +/- 1% of nominal voltage

4. Over/under frequency sensing:
   a. Pickup: +/- 5 to +/-20% of nominal frequency (default 10%)
   b. Dropout: +/-1% beyond pickup (default 1%)
   c. Dropout time delay: 0.1 to 15.0 seconds (default 5 sec)
   d. Accurate to within +/- 0.2%

5. Voltage imbalance sensing:
   a. Dropout: 2 to 10% (default 4%)
   b. Pickup: 90% of dropout
   c. Time delay: 2.0 to 20 seconds (default 5 sec)

6. Phase rotation sensing:
   a. Time delay: 100 msec

7. Loss of single-phase detection:
   a. Time delay: 100 msec

I. Control features shall include:
1. Programmable genset exerciser: To ensure that standby system is always functioning correctly, a programmable control shall periodically start the generator, transfer the load to generator for a preset time, then re-transfer and shut down the generator after a preset cool-down period.
   a. Push-button programming control shall permit programming of one exercise time on a repeating schedule.
   b. Push-button programming control shall have a selection of eight different schedules for exercising generator, with or without load.

2. In event of a loss of power to the control, all control settings, real-time clock setting and the engine start-time delay setting will be retained.

3. The system continuously logs information including the number of hours each source has been connected to the load, the number of times transferred, and the total number of times each source has failed. An event recorder stores information, including time and date-stamp, for up to 50 events.

4. Transfer Override Switch: Overrides automatic re-transfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light to indicate override status.

J. Control Interface
1. Provide one set Form C auxiliary contacts on both sides, operated by transfer switch position, rated 10 amps 250 VAC.
2. The transfer switch shall be provided with a network communication card, and configured to allow network-based communication with the transfer switch and other network system components, including the generator set(s) provided for the Project.
3. Unassigned Auxiliary Contacts: Two normally open, 1-pole, double-throw contacts for each switch position, rated 10A at 240 VAC.

K. Engine Starting Contacts
1. One isolated and normally closed, and one isolated and normally open; rated 10A at 32 VDC minimum.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Design each fastener and support to carry load.
B. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Floor-mounted transfer switches shall be mounted on concrete bases complying with the following requirements:
      a. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to manufacturer size and weight requirements.
C. Identify components according to Division 26 Section "Identification for Electrical Systems."
D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
B. Field control connections shall be made on a common terminal block that is clearly and permanently labeled.
C. Transfer switch shall be provided with AL/CU mechanical lugs sized to accept the full output rating of the switch. Lugs shall be suitable for the number and size of conductors shown on the drawings.
D. Ground equipment according to NFPA 70 (NEC) requirements.
E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
3.03 **SOURCE QUALITY CONTROL**

A. Prior to shipping, factory shall test and inspect components, assembled switches, and associated equipment to ensure proper operation.

B. Factory shall check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements.

C. Factory shall perform dielectric strength test complying with NEMA ICS 1.

3.04 **FIELD QUALITY CONTROL**

A. Manufacturer's Field Service: The supplier of the transfer switch(es) and associated equipment shall inspect, test, and adjust components, assemblies, and equipment installations, including connections, and report results in writing.

B. Manufacturer's representative shall perform tests and inspections and prepare test reports.

C. After installing equipment and after electrical circuitry has been energized, installer shall test for compliance with requirements.
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
      a. Check for electrical continuity of circuits and for short circuits
      b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features
      c. Verify that manual transfer warnings are properly placed
      d. Perform manual transfer operation
   3. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
      a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available
      b. Simulate loss of phase-to-ground voltage for each phase of normal source.
      c. Verify time-delay settings.
      d. Verify pickup and dropout voltages by data readout or inspection of control settings.
      e. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
      f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 % from other poles.
      g. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.
   4. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
a. Verify grounding connections and locations and ratings of sensors.

D. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
   1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.05 DEMONSTRATION

A. After generator set installation, the generator and transfer switch supplier shall conduct a complete operation, basic maintenance, and emergency service seminar covering generator set and transfer switch equipment, for up to 5 people employed by the Owner.
   1. The seminar shall include instruction on operation of the transfer equipment, normal testing and exercise, adjustments to the control system, use of the PC based service and maintenance tools provided under this contract, and emergency operation procedures.
   2. The class duration shall be at least 4 hours in length, and include practical operation with the installed equipment.

3.06 SERVICE AND SUPPORT

A. The manufacturer shall supply the Owner with a complete set of the service and maintenance software required to support the product. The software shall be provided at a training class attended by the user, to qualify the user in proper use of the software. The software shall have the following features and capabilities:
   1. The software shall be 32 bit and shall be Windows 2000 or XP compatible.
   2. The software shall use the Windows Explorer format, for ease of use and commonality with other software in use at the facility.
   3. The software shall allow adjustment of all functions described herein, adjustment of operating levels of all protective functions, and programming of all optional functions in the controller. Adjustments shall be possible over modem from a facility that is remote from the generator set.
   4. The software shall be capable of storing and displaying data for any function monitored by the generator set control. This data shall be available in common file formats, and on graphical “strip chart” displays.
   5. The software shall automatically record all control operations and adjustments performed by any operator or software user, for tracking of changes to the control.
   6. The software shall display all warning, shutdown, and status changes programmed into transfer switch controller. For each event, the control shall provide information on the nature of the event, when it last occurred, and how many times it has occurred.

END OF SECTION 26 36 00
SECTION 26 51 00 - INTERIOR LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 SUMMARY

A. This Section includes the following:
   1. Interior lighting fixtures.
   2. Exit signs.
   3. Lighting fixture supports.

1.04 DEFINITIONS

A. CRI: Color-rendering index.
B. CU: Coefficient of utilization.
C. LER: Luminaire efficacy rating.
D. Luminaire: Complete lighting fixture, including LEDs/lamps, drivers/ballasts, and housing.

1.05 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of lighting fixture including dimensions.
   2. Emergency lighting units including battery and charger.
   3. Life, output, and energy-efficiency data.
B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories.
C. Coordination Drawings: Reflected ceiling plan(s) and other details, 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. Lighting fixtures.
   2. Suspended ceiling components.
   3. Structural members to which suspension systems for lighting fixtures will be attached.
   4. Other items in finished ceiling including the following:
      a. Air outlets and inlets.
b. Speakers.
c. Sprinklers.
d. Smoke and fire detectors.
e. Occupancy sensors.
f. Access panels.

D. Field quality-control test reports.
E. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
F. DLC Certification for LED fixtures: Provide lighting facts documentation.
G. Warranties: Special warranties specified in this Section.

1.06 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. All LED fixtures are to be tested and should adhere to IESNA LM79 testing standards for lumen output and depreciation.
C. All LED fixtures are to be tested to LM80 standards.
D. Comply with NFPA 70.

1.07 COORDINATION
A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.08 WARRANTY
A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
   1. Warranty Period for Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
B. Warranty for LED luminaires: Manufacturer's standard form, made out to Owner and signed by luminaire manufacturer agreeing to replace any component of the luminaire that fails in materials or workmanship, f.o.b. the nearest shipping point to Project site, within specified warranty period indicated below.
   1. Warranty Period: 5 years from date of Substantial Completion.

1.09 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. Plastic Diffusers and Lenses: 1 of each type and rating installed.
   2. Guards: 1 for every 20 of each type and rating installed. Furnish at least one of each type.
PART 2 - PRODUCTS

2.01 MANUFACTURERS
A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Basis-of-Design Product: The design for each lighting fixture is based on the product named on the drawings. Subject to compliance with requirements, provide either the named product or a comparable product by another manufacturer.

2.02 LIGHTING FIXTURES AND COMPONENTS, GENERAL REQUIREMENTS
A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
C. Metal Parts: Free of burrs and sharp corners and edges.
D. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging.
E. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally when secured in operating position.
F. Reflecting surfaces shall have minimum reflectance as follows, unless otherwise indicated:
   1. White Surfaces: 85 percent.
   2. Specular Surfaces: 83 percent.
   3. Diffusing Specular Surfaces: 75 percent.
   4. Laminated Silver Metallized Film: 90 percent.

2.03 LED LUMINAIRES AND ACCESSORIES
A. Description:
   1. All fixtures are to be tested and should adhere to IESNA LM79 testing standards for lumen output and depreciation.
   2. All fixtures are to be tested to LM80 standards.
   3. All fixtures are to be DLC certified.
   4. All fixtures are to be rated to deliver L80 performance for a minimum of 50,000 hours.
   5. All fixtures are to be equipped with a 0-10V dimming driver.

2.04 LIGHTING FIXTURE SUPPORT COMPONENTS
A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.
H. Fixtures in apparatus bay shall be suspended to mounting height indicated on plans with threaded steel rod and slotted steel supports, and braced against any swinging.

2.05 EXIT SIGNS
A. Description: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
B. Internally Lighted Signs:
   1. Lamps for AC Operation: LEDs, 70,000 hours minimum rated lamp life.
   2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
      a. Battery: Sealed, maintenance-free, nickel-cadmium type.
      b. Charger: Fully automatic, solid-state type with sealed transfer relay.
      c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
      d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
      e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

PART 3 - EXECUTION

3.01 INSTALLATION
A. Lighting fixtures: Set level, plumb, and square with ceilings and walls.
B. Support for Lighting Fixtures in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.
   2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
   3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
C. Suspended Lighting Fixture Support:
   1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace against swinging.
   3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.02 FIELD QUALITY CONTROL
A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 51 00
SECTION 26 56 00 - EXTERIOR LIGHTING

PART I - GENERAL

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

1.02 RELATED DOCUMENTS
A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING “UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT” APPLY TO THIS SECTION.

1.03 SUMMARY
A. This Section includes the following:
   1. Exterior luminaires.
   2. Poles and accessories.
B. Related Sections include the following:
   1. Division 26 Section "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.04 DEFINITIONS
A. CRI: Color-rendering index.
B. Luminaire: Complete lighting fixture.
C. Pole: Luminaire support structure.
D. Standard: Same definition as "Pole" above.

1.05 SUBMITTALS
A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
   1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
   2. Details of attaching luminaires and accessories.
   3. Details of installation and construction.
   4. Luminaire materials.
   5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps and accessories.
a. Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

7. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
8. Anchor bolts for poles.

B. Shop Drawings:
1. Anchor-bolt templates keyed to specific poles and certified by manufacturer.
2. Design calculations, certified by a qualified professional engineer, indicating strength of screw foundations and soil conditions on which they are based.

C. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4 and that load imposed by luminaire has been included in design.

D. Qualification Data: For agencies providing photometric data for lighting fixtures.
E. Field quality-control test reports.
F. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.
G. Warranty: Special warranty specified in this Section.

1.06 QUALITY ASSURANCE
A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

1.07 DELIVERY, STORAGE, AND HANDLING
A. Package aluminum poles for shipping according to ASTM B 660.
B. Store poles on decay-resistant-treated skids at least 12 inches (300 mm) above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

1.08 WARRANTY
A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain,
perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.

1. Warranty Period for Luminaires: Five years from date of Substantial Completion.
2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion.
3. Warranty Period for Color Retention: Five years from date of Substantial Completion.
4. Warranty Period for Poles: Repair or replace lighting poles and standards that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

B. Basis of Design Product: The design of each item of exterior luminaire and its support is based on the product named on the drawings. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.02 LUMINAIRES, GENERAL REQUIREMENTS

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
B. Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
C. Metal Parts: Free of burrs and sharp corners and edges.
D. Sheet Metal Components: Corrosion-resistant aluminum, unless otherwise indicated. Form and support to prevent warping and sagging.
E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
F. 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. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
G. Exposed Hardware Material: Stainless steel.
H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
K. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.


2.03 POLES AND SUPPORT COMPONENTS, GENERAL REQUIREMENTS

N. Structural Characteristics: Comply with AASHTO LTS-4.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in Part 1 "Structural Analysis Criteria for Pole Selection" Article, with a gust factor of 1.3.

O. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts, unless otherwise indicated.

P. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication, unless stainless-steel items are indicated.

3. Anchor-Bolt Template: Plywood or steel.

Q. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

R. Power-Installed Screw Foundations: Factory fabricated by pole manufacturer, with structural steel complying with ASTM A 36/A 36M and hot-dip galvanized according to ASTM A 123/A 123M; and with top-plate and mounting bolts to match pole base flange and strength required to support pole, luminaire, and accessories.

S. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4.

2.04 STEEL POLES

T. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); 1-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: As indicated on fixture schedule.

2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

U. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole and bracket, then bolted together with stainless-steel bolts.

2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

V. Intermediate Handhole and Cable Support: Weathertight, 3-by-5-inch (76-by-127-mm) handhole located at bottom of pole with cover for access to internal welded attachment lug for electric cable support grip.

W. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

X. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

Y. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

PART 3 - EXECUTION

3.01 LUMINAIRE INSTALLATION

A. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

B. Adjust luminaires that require field adjustment or aiming.

3.02 POLE INSTALLATION

A. Retain paragraph below if luminaire alignment for desired light distribution depends on alignment of pole.

B. Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

C. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features, unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm)
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m)
3. Trees: 15 feet (5 m)

D. Coordinate first five paragraphs and associated subparagraphs below with Drawings. See Evaluations for structural- and soil-engineering coordination.

E. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer.

F. Note that pole foundations are to have built-in receptacle boxes in lockable enclosure per the plans.

G. Foundation-Mounted Poles: Mount pole with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.
2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.
3. Install base covers, unless otherwise indicated.
4. Use a short piece of 1/2-inch- (13-mm-) diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

H. Raise and set poles using web fabric slings (not chain or cable).

3.03 CORROSION PREVENTION
A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
B. Steel Conduits: Comply with Division 26 Section "Raceway and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.04 GROUNDING
A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."
   1. Install grounding electrode for each pole, unless otherwise indicated.
   2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.05 FIELD QUALITY CONTROL
A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
C. Test fixture operation with lighting controls and verify proper operation with control elements specified.
D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 26 56 00
SECTION 26 83 10 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

1.02 RELATED DOCUMENTS

A. DRAWINGS AND GENERAL PROVISIONS OF THE CONTRACT, INCLUDING
   "UNIFORM GENERAL CONDITIONS FOR STATE OF TEXAS CONSTRUCTION
   CONTRACTS INCLUDING SUPPLEMENTARY GENERAL CONDITIONS FOR
   PROJECTS ADMINISTERED BY THE TEXAS PARKS AND WILDLIFE DEPARTMENT"
   APPLY TO THIS SECTION.

1.03 SUMMARY

A. This Section includes the following:
   1. Fire-alarm control unit.
   3. System smoke detectors.
   6. Addressable interface device.
   7. Digital alarm communicator transmitter.

1.04 DEFINITIONS

A. ADA: Americans with Disabilities Act.

B. FACP: Fire alarm control panel.

C. LED: Light-emitting diode.


E. Definitions in NFPA 72 apply to fire alarm terms used in this Section.

1.05 SYSTEM DESCRIPTION

A. Non-coded addressable system, with automatic sensitivity control of certain smoke detectors
   and multiplexed signal transmission, dedicated to fire-alarm service only.
1.06 SUBMITTALS

A. General Submittal Requirements:
   1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect. Include comments from authorities having jurisdiction in submittal package to Architect.
   2. Shop Drawings shall be prepared by persons with the following qualifications:
      a. Trained and certified by manufacturer in fire-alarm system design.
      b. NICET-certified fire-alarm technician, Level III minimum.
      c. Licensed or certified by authorities having jurisdiction, if required.

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

C. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work
   2. Include detailed system operation description for this Project, including method of operation and supervision of each type of circuit and Sequence of Operations Matrix for manually and automatically initiated system inputs and outputs. Manufacturer’s standard descriptions for generic systems are not acceptable.
   3. Include system riser diagram with device address, conduit sizes, and cable and wire types and sizes.
   4. Include wiring diagrams for power, signal, and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
   5. Include voltage drop calculations for notification appliance circuits.
   6. Include battery-size calculations.
   7. Include performance parameters and installation details for each detector, verifying that each detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
   8. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer’s written recommendations.
   9. Include voice/alarm signaling-service equipment rack or console layout grounding schematic, amplifier power calculation, and single-line connection diagram.
   10. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

D. Qualification Data: For qualified Installer.

E. Field quality-control reports.

F. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section “Operation and Maintenance Data,” include the following:
1. Comply with the “Records” Section of the “Inspection, Testing and Maintenance” Chapter in NFPA 72.
2. Provide “Record of Completion Documents” according to NFPA 72 article “Permanent Records” in the “Records” Section of the “Inspection, Testing and Maintenance” Chapter.
3. Record copy of site-specific software.
4. Provide “Maintenance, Inspection and Testing Records” according to NFPA 72 article of the same name and include the following:
   a. Frequency of testing of installed components.
   b. Frequency of inspection of installed components.
   c. Requirements and recommendations related to results of maintenance.
   d. Manufacturer’s user training manuals.
5. Manufacturer’s required maintenance related to system warranty requirements.
6. Abbreviated operating instructions for mounting at fire-alarm control unit.
7. Copy of NFPA 25.

G. Software and Firmware Operational Documentation:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On magnetic media or compact disk, complete with data files.
   3. Device address list.
   4. Printout of software application and graphic screens.

1.07 QUALITY ASSURANCE

A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician. Personnel shall be trained and certified by manufacturer for installation of units required for this Project.

B. Source Limitations for Fire-Alarm System and Components: Obtain fire-alarm system from single source from single manufacturer.

C. Electrical Components, Devices and Accessories: Listed and labeled as defined by NFPA 70, by a qualified testing agency, and marked for indeed location and application.

D. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company or as required by authorities having jurisdiction.

1.08 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
1. Provide 30 days’ notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.09 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no less than one unit.
   2. Lamps for Strobe Units: Quantity equal to 10 percent of amount of each type installed, but no less than one unit of each type.
   3. Smoke Detectors, Heat Detectors: Quantity equal to 10 percent of amount of each type installed, but no less than one unit of each type.
   4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no less than one unit of each type.
   5. Keys and Tools: One extra set for access to locked and tamper-proofed components.
   6. Audible and Visual Notification Appliances: Two of each type installed.
   7. Fuses: Two of each type installed in the system.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or engineer approved equal:
   1. FACP and Equipment:
      a. Honeywell
      b. Potter
      c. Edwards
      d. Or equal
   2. Cellular Dialer:
      a. DSC 3G4010 V4.0/LE4010 V5.0
      b. Or equal
   3. Wire and Cable:
      a. Comtran Corporation.
      b. Helix/HiTemp Cables, Inc.; a Draka USA Company.
      c. Rockbestos-Suprenant Cable Corporation; a Marmon Group Company.
      d. West Penn Wire/CDT; a division of Cable Design Technologies.
   4. Audible and Visual Devices:
      a. Amseco; a division of Kobishi America, Inc.
      b. Commercial Products Group.
      c. Gentex Corporation.
      d. System Sensor; a GE-Honeywell Company.
      e. Wheelock, Inc.
2.02 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Automatic sprinkler system water flow.

B. Fire-alarm shall initiate the following actions:
1. Continuously operate alarm notifications appliances.
2. Identify alarm at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Activate voice/alarm communication system.
7. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
8. Activate stairwell pressurization systems.
9. Close smoke dampers in air ducts of designated air-conditioning duct systems.
10. Activate emergency lighting control.
11. Record events in the system memory.
12. Record events by the system printer.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or single break in fire-alarm control unit internal circuits.
5. Abnormal 1 ac voltage at fire-alarm control unit.
7. Failure of batter charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators. Record the even on system printer.

2.03 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
   a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
b. Include a real-time clock for time annotation of events on the event recorder and printer.

2. Addressable initiation devices that communicate device identity and status.
   a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
   b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory and component status messages and the programming and control menu.
   1. Annunciator and Display: Liquid-crystal type, 2 lines of 40 characters, minimum.
   2. Keypad: Arranged to permit entry and execution of programming, display and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Circuits:
   1. Initiating Device, Notification Appliance, and Signaling Line Circuits, NFPA 72, Class B, unless indicated otherwise.
      a. Initiating Device Circuits: Style B, unless indicated otherwise.
      b. Notification Appliance Circuits: Style Y, unless indicated otherwise.
      c. Signaling Line Circuits: Style 4, unless indicated otherwise.
      d. Install no more than 50 addressable devices on each signaling line circuit.

D. Serial Interfaces: Two RS-232 ports for printers.

E. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

F. Walk Test: A test mode to allow one person to test alarm and supervisory features of initiating devices. Enabling of this mode shall require the entry of a password. The FACP and annunciators shall display a test indication while the test is underway. If testing ceases while in walk-test mode, after a preset delay, the system shall automatically return to normal.

G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and printout the final adjusted values on system printer.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.

I. Printout of Events: On receipt of signal, print alarm, supervisory, and trouble events. Identify zone, device, and function. Include type of signal (alarm, supervisory, or trouble) and date and date.
time of occurrence. Differentiate alarm signals from all other printed indications. Also print system reset event, including same information for device, location, date, and time. Commands initiate the printing of a list of existing alarm, supervisory, and trouble conditions in the system and a historical log of events.

J. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

K. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.


L. Surge Protection:

1. Install surge protection on normal ac power for the FACP and its accessories.
2. Install surge protectors recommended by FACP manufacturer. Install on all system wiring external to the building housing the FACP.

M. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless–steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.04 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer’s surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.05 SYSTEM SMOKE DETECTORS

A. General Requirement for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc; nominal
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type indicated detector has operated and power-on status.

7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
   a. Rate-of-rise temperature characteristics shall be selectable at fire-alarm control unit of 15 to 20 deg F per minute.
   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F.
   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector’s location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

C. Ionization Smoke Detector:
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector’s location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).

D. Duct Smoke Detector: Photoelectric type complying with UL 268A.
   1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector’s location within the system and its sensitivity setting.
   2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
      a. Primary status.
      b. Device type.
      c. Present average value.
      d. Present sensitivity selected.
      e. Sensor range (normal, dirty, etc.).
   3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
   4. Each sensor shall have multiple levels of detection sensitivity.
   5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
2.06 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

C. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
   1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
   2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.07 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Individually addressed, connected to a signaling line circuit, equipped for mounting as indicated and with screw terminals for system connections.
   1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word “FIRE” is engraved in minimum 1-inch-high letters on the lens.
   1. Rated Light Output: 15/30/75/110 cd, selectable in the field.
   2. Mounting: Wall mounted unless otherwise indicated.
   3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
   4. Flashing shall be in a temporal pattern, synchronized with other units.
   5. Strobe Leads: Factory connected to screw terminals.

2.08 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.

B. Integral Relay: Capable of providing a direct signal, including:
   1. To circuit-breaker shunt trip of power shutdown.
2.09 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.
   1. Factory fabricated and furnished by manufacturer device.
   2. Finish: Paint of color to match the protected device.

2.010 WIRE AND CABLE

A. Wire and cable for the fire-alarm systems shall be UL listed and labeled as complying with NFPA 70, Article 760.

B. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.
   1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire-alarm signal service. UL listed as TYPE FPL, and complying with requirements in UL 1424 and UL 2196 for a 2-hour rating.

   1. Low-Voltage Circuits: No. 14 AWG, minimum.
   2. Line-Voltage Circuits: No 12 AWG, minimum.
   3. Multi-Conductor Armored Cable: NFPA 70 Type MC, copper conductors, TFN/THHN conductor insulation, copper drain wire, copper armor (with outer jacket where required) with red identifier stripe, UL listed for fire alarm and cable try installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.011 FIRE ALARM COMMUNICATOR / CELLULAR DIALER

A. Description: Communicator panel that sends fire alarm system information through LTE or internet channels to a central monitoring station.
   1. System to include built in UL listed power supply with battery supervision.
   2. System to be compliant with UL864
   3. Diagnostic LED’s indicating signal strength and status indicators.
   4. Ethernet 10/100 port compatible.

PART 3 - EXECUTION

3.01 EQUIPMENT INSTALLATION

A. Comply with NFPA 72 for installation of fire-alarm equipment.

B. Equipment Mounting for Wall-Mounted Units: Install fire-alarm control unit on walls with tops of cabinets not more than 72 inches above the finished floor.

C. Smoke- or Heat-Detector Spacing:
   1. Comply with NFPA 72, Smoke-Sensing Fire Detectors” Section in the “Initiating Devices” Chapter, for smoke-detector spacing.
3. Smooth ceiling spacing shall not exceed 30 feet.
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
5. HVAC: Locate detectors not closer than three feet from air-supply diffuser on return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture.

D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

E. Signaling Line Circuits: Install no more than 50 addressable devices on each signaling line circuit.

F. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

G. Audible Alarm-Indicating Devices: Install at least 6 inches below the ceiling. Install on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.

H. Visible Alarm-Indicating Devices: Install at least 6 inches below the ceiling.

I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

J. Fire-Alarm Control Unit: Surface mounted, with tops of cabinets not more than 72 inches above the finished floor.

K. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

3.02 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section “Door Hardware.” Connect hardware and devices to fire-alarm system.
   1. Verify that hard and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than three feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
   1. Alarm-initiating connection to stairwell pressurization systems.
   2. Smoke dampers in air ducts of designated air-conditioning duct systems.
   3. Alarm-initiating connection to activate emergency lighting control.
   4. Supervisory connections at valve supervisory switches.
   5. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
6. Supervisory connections at fire-pump power failure including a dead-phase or phase-reversal condition.

3.03 WIRING INSTALLATION

A. Install wiring according to the following:
1. NECA 1.
2. TIA/EIA 568-A.

B. Wiring Method: Install wiring in metal raceway according to Division 16 Section “Raceways and Boxes.”
1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system’s wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

E. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

F. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum 1-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section “Identification for Electrical Systems.”

B. Install framed instructions in a location visible from fire-alarm control unit.
3.05  GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.06  FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.07  DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 26 83 10
PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes general administrative and procedural requirements for Division 27 and 28, and is intended to supplement, not supersede, the requirements specified in Division 01.

B. Provide completely functioning communications systems.

C. Comply with FAR clause 52.236-21 in circumstance of a need for additional detail or conflict between drawings, specifications, reference standards or code.

D. The requirements described herein include the following:
   1. References
   2. Definitions
   3. Submittals
   4. Quality Assurance
   5. Delivery, Storage, and Handling
   6. Scheduling
   7. Warranty
   8. Product Substitutions
   9. Project Management and Coordination Services
  10. Permits and Inspections
  11. Field Quality Control
  12. Project Closeout and Record Documents

E. Related Items
   1. General and Supplementary Conditions: General provisions of Contract and Division 01 apply to Division 27.
   2. Consult other Divisions and Sections, determine the extent and character of related work, and coordinate Work of Division 27 with that specified elsewhere to produce a complete and operable installation.

1.02 REFERENCES

A. General
   1. Codes, standards, and industry manuals/guidelines listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Consider such codes and/or standards a part of this Specification as though fully repeated herein.
   2. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
   3. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid unless otherwise specifically stated.
B. Codes: Perform Work and furnish materials and equipment under Division 27 in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:

1. United States Department Of Labor (DOL) Occupational Safety and Health Administration (OSHA) Regulations (Standards - 29 CFR)
   a. Part 1910, “Occupational Safety and Health Standards”
   b. Part 1926, “Safety and Health Regulations for Construction”

2. Texas Accessibility Standards (TAS)

3. Texas Administrative Code


   a. Part 15, Radio Frequency Devices & Radiation Limits
   b. Part 24, Personal Communications Services
   c. Part 27, Miscellaneous Wireless Communications Services
   d. Part 68, Connection of Terminal Equipment to the Telephone Network

6. National Fire Protection Agency (NFPA)
   a. NFPA 70, “National Electrical Code” (NEC)
   b. NFPA 75, “Protection Of Information Technology Equipment”
   c. NFPA 262, “Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces”,

7. Other national, state, and local binding building and fire codes

C. Standards: Perform Work and furnish materials and equipment under Division 27 in accordance with the latest editions of the following standards as applicable:

1. Underwriter's Laboratories (UL): Applicable listing and ratings, including but not limited to the following standards:
   a. UL 444, “Communications Cables”
   b. UL 497, “Protectors for Paired-Conductor Communication Circuits”
   c. UL 497A, “Secondary Protectors for Communications Circuits”
   d. UL 497B, “Protectors for Data Communications and Fire-Alarm Circuits”
   e. UL 1651, “Optical Fiber Cable”
   f. UL 1666, “Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts “
   g. UL 1690, “Data-Processing Cable “
   h. UL 1963, “Communications-Circuit Accessories”
   i. UL 2024A, “Optical Fiber Cable Routing Assemblies”

2. ANSI/TIA/EIA-568 Series:

3. ANSI/TIA-569-B, “Commercial Building Standard for Telecommunications Pathways and Spaces”

4. ANSI/TIA/EIA-598, “Optical Fiber Cable Color Coding”

6. ANSI/J-STD-607-A, “Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications”

7. ANSI/TIA/EIA-758, “Customer-Owned Outside Plant Telecommunications Cabling Standard”, including the following addenda

8. ANSI/TIA-1005, “Telecommunications Infrastructure Standard for Industrial Premises”

9. EIA testing standards

10. Insulated Cable Engineers Association (ICEA):
    c. ANSI/ICEA S-87-640-1999, “Fiber Optic Outside Plant Communications Cable”
    d. ANSI/ICEA S-90-661-2002, “Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cable for Use In General Purpose and LAN Communication Wiring Systems”
    e. ICEA S-102-700-2004, “ICEA Standard For Category 6 Individually Unshielded Twisted Pair Indoor Cables (With Or Without An Overall Shield) For Use In Communications Wiring Systems Technical Requirements”
    f. ICEA S-104-696-2001, “Indoor-Outdoor Optical Cable”

    a. Telecommunications Distribution Methods Manual (TDMM)
    c. Wireless Design Reference Manual (WDRM)

12. IEEE-802 – Standards
    a. IEEE-802.3af Power Over Ethernet (PoE) Standard
    b. IEEE-802.3af Power Over Ethernet + (PoE+) Standard
    c. IEEE-802.3an Physical Layer and Management for 10Gbps – 10BASE-T
    d. IEEE-802.11 Wireless Standard

D. Make a copy of each document readily available during the course of construction for reference by field personnel.

1.03 DEFINITIONS

A. The Definitions of Division 01 shall apply to Division 27 sections.

B. In addition to those Definitions of Division 01, the following list of terms as used in this specification defined as follows:

1. “As directed”: As directed or instructed by the Owner, or their authorized representative
2. “Cabling”: A system comprised of cables, wire, cords, and connecting hardware [e.g., cables, termination apparatus, patch panels, blocks, connectors, outlets, labeling, etc]
3. “Connect”: To install required patch cords, equipment cords, crossconnect wire, etc. to complete an electronic or optical signal circuit
4. “Cord”: a length of cordage having connectors at each end. The term “Cord” is synonymous with the term “Jumper” and “Lead”
5. “Engineer”: MEPCE
6. “Furnish”: To purchase, procure, acquire, and deliver complete with related accessories
7. “Identifier”: A unique code assigned to an element of the Telecommunications infrastructure that links it to its corresponding record
8. “Install”: To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to the Owner, parts, items, or equipment supplied by contractor or others. Make installation complete and ready for regular operation
9. “Pigtail”: a length of cordage having connectors at one end
10. “Provide”: To furnish, transport, install, erect, connect, test and turn over to the Owner, complete and ready for regular operation

1.04 SYSTEM DESCRIPTION AND PROJECT CONDITIONS

A. In circumstances where the Specifications and Drawings conflict, the Drawings shall govern quantity and the Specifications shall govern quality.

1.05 SUBMITTALS

A. Submit required submittals to the General Contractor in the quantities and formats as required under the general contract. In the absence of requirements, provide as described in the following with reference to quantity and format.

B. Failure to comply with requirements in part or whole shall constitute grounds for rejection.

C. Submittal Description: Product Data
1. Obtain written approval from the Engineer for the product data submittal prior to materials and equipment purchase order and prior to installation.
2. Quantity: Submit product data as described in Division 01. In the absence of requirements given, submit four product data submittals.
3. Format:
   a. Submit each product data on letter size (8.5” x 11”) paper.
   b. Package product data using a 3-ring binder, plastic cover, or similar.
   c. Clearly label the cover and spine of each submittal with the following information (e.g., if in a 3-ring binder, insert the submittal information in the transparent front cover and spine pockets):
      1) Client Name
      2) Project Name and Address
      3) Project Submittal Number
      4) Submittal Name
      5) Specification Section Number
      6) Date of Submittal. Format: Month Day, Year
      7) Contractor Name
   d. Include a Table Of Contents at the beginning of the submittal that lists materials by article and paragraph number (e.g., “2.02 Equipment Racks”).
   e. Include tabbed separators for improved navigation through the submittal.
4. Content:
   a. Cover Letter: Include a cover letter stating that the submittal is in full compliance with the requirements of the Contract Documents. Sign (and stamped, if applicable) cover letter and list items and data submitted.
   b. Product Information: Include manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary) to clearly describe the product’s characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by arrows or brackets precisely
what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in Division 27. Include relevant products that will be installed, which are not listed in the specifications.

c. Resubmittals: Provide a cover letter with the resubmittal that lists the action taken and revisions made to each product submittal in response to Submittal Review Comments. No review shall take place for any resubmittal packages that is not accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the resubmittal package.

D. Submittal Description: Shop Drawings
1. Prior to the start of work, submit shop drawings and obtain written approval from the Engineer for the shop drawings submittal.
2. Provide cable pulling plan in addition to other required shop drawings.
3. Quantity and Media: Submit shop drawings as described in Division 01. In the absence of requirements given, submit four full-size sets of shop drawings on bond or “eco-bond”.
4. Format:
   a. Produce shop drawings using AutoDesk Revit, or other computer design application that can save files to AutoDesk Revit-compatible files.
   b. Use the same sheet size as the drawings of the Contract Documents.
   c. Use the project’s title block – same as the drawings of the Contract Documents.
   d. Text: minimum of 3/32” high when plotted at full size.
   e. Use identical symbols as those in the drawings.
   f. Screen background information.
   g. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.
   h. Label each sheet in the shop drawings set with the Specification Section Number (e.g., “271523”).
   i. Scaling:
      1) Scale floor plans at 1/8”=1’-0”
      2) Scale enlarged room plans at 1/4”=1’-0”
      3) Scale wall elevations at 1”=1’-0”
      4) Scale rack elevations at 1”=1’-0”
5. Content:
   a. Submit shop drawings if the proposed installation differs from the Contract Documents or the design intent.
   b. Cover Letter: Accompany each shop drawing submittal with a cover letter stating that the shop drawings have been thoroughly reviewed by the Contractor and are in full compliance with the requirements of the Contract Documents. Have the person who prepared the submittal sign (and stamped, if applicable) the cover letter and include a drawing index. Failure to comply with this requirement shall constitute grounds for rejection of submittal.
   c. Drawing Information: Shop drawing submittals shall consist of floor plans, enlarged room plans, wall and rack elevations, installation details, and other aspects of the system that differ from the Contract Documents or the design intent. Use the same scales as the Drawings (e.g., 1/4” = 1’-0” for enlarged room plans).
   d. Resubmittals: Accompany resubmittals with a cover letter that lists the revisions made to each drawing in response to Submittal Review Comments. Failure to include this cover letter will constitute rejection of the resubmittal package without review.

E. Submittal Description: As-Built Drawings
1. Quantity and Media: Submit as-built drawings as described in Division 01. In the absence of requirements given, submit one full-size set of shop drawings on bond or “eco-bond” and submit one set of electronic files on DVD-ROM.
2. Format:
a. Produce as-built drawings using AutoDesk Revit, or other computer design application that can save files to AutoDesk Revit-compatible files.
b. Use the same sheet size as the drawings of the Contract Documents.
c. Use the project’s title block – same as the drawings of the Contract Documents.
d. Text: minimum of 3/32” high when plotted at full size.
e. Use symbols identical to the symbols shown on the Drawings.
f. Screen background information.
g. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.

3. Content:
   a. Submit as-built drawings that fully represent actual installed conditions and that incorporate modifications made during the course of construction.
   b. Floor Plans: Scale floor plans at 1/8”=1'-0". Floor plans shall show:
      1) Locations and identifiers of telecommunications devices.
      2) Size, quantity, location, and routes of pathways (such as cable trays, cable basket, conduits 2" trade size or larger.
   c. Rooms Drawings: Applicable rooms: EF, ER & TR. Room drawings shall show:
      1) Floor layouts – scaled at either 1/4”=1'-0” showing dimensioned placement of equipment cabinets/frames, rack bays, etc.
      2) Overhead layouts – scaled at either 1/4”=1'-0” showing dimensioned placement of overhead cable support (e.g., cable tray, cable runway, basketway, conduit sleeves, etc.)
      3) Rack elevations – scaled at 1”=1'-0”, showing placement of termination apparatus and other equipment installed onto rack bays
      4) Wall Elevations – scaled at 1”=1'-0”, showing dimensioned placement of terminati

F. Submittal Description: Operation and Maintenance (O&M) Manuals for Active Systems
   1. Quantity: Submit quantity of O&M Manuals as described in Division 01. In the absence of requirements given, submit four O&M Manuals.
   2. Format:
      a. Submit each O&M Manual in a white, 3-ring binder with front cover and spine clear pockets for insertion of the project information.
      b. Clearly label the cover of each O&M Manual with the following information:
         1) Client Name
         2) Project Name and Address
         3) Manual Name (e.g., “Operation And Maintenance Manual for Telecommunications Cabling System”)
         4) Date of Submittal. Format: Month Day, Year (e.g., “January 1, 2010”)
         5) Contractor Name
      c. Include a Table Of Contents at the beginning that lists the contents.
      d. Include tabbed separators for improved navigation through the manual.
   3. Content:
      a. Tabloid (17”x11”) prints of as-built drawings, as described above
      b. Manufacturer's original catalog information sheets for each component provided under applicable Section (typically, this is similar to the accepted product data submittal)
      c. Warranty certificate from the manufacturer and the Contractor
      d. Manufacturer’s instructions for system or component use
      e. Instructions and requirements for maintenance and warranty issues
      f. Contents shall include requirements and methods for maintaining installed products, and precautions against cleaning materials and methods detrimental to finishes and performance.

G. Submittal Description: Operation and Maintenance (O&M) Manuals for Passive Systems
1. Quantity: Submit quantity of O&M Manuals as described in Division 01. In the absence of requirements given, submit four O&M Manuals.

2. Format:
   a. Submit each O&M Manual in a white, 3-ring binder with front cover and spine clear pockets for insertion of the project information.
   b. Clearly label the cover of each O&M Manual with the following information:
      1) Client Name
      2) Project Name and Address
      3) Manual Name (e.g., “Operation And Maintenance Manual for Telecommunications Cabling System”)
      4) Date of Submittal. Format: Month Day, Year
      5) Contractor Name
   c. Include a Table Of Contents at the beginning that lists the contents.
   d. Include tabbed separators for improved navigation through the manual.

3. Content:
   a. Tabloid (17”x11”) prints of as-built drawings, as described above
   b. Manufacturer's original catalog information sheets for each component provided under applicable Section (typically, this is similar to the accepted product data submittal)
   c. Warranty certificate from the manufacturer and the Contractor

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications
   1. Five continuous years, minimum, design and manufacture of the materials and equipment specified herein.
   2. Manufacturer(s) of products and equipment specified herein shall demonstrate that they have a quality assurance program in place to assure that the specifications are met. Include in the program, at a minimum, provisions for:
      a. Incoming inspection of raw materials
      b. In-process inspection and final inspection of the cable product
      c. Calibration procedures of test equipment to be used in the qualifications of the product
      d. Recall procedures in the event that out of calibration equipment is identified.
   3. Conform to government standards on quality assurance for applications within these specifications.

B. Materials
   1. Materials, support hardware, equipment, parts comprising units, etc., shall be new, unused, without defects and of current manufacturer, materials
   2. Use specified products and applications, unless otherwise submitted and approved in writing.

C. Regulatory Requirements
   1. Work and materials shall conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and shall conform to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Work under Division 27 shall confirm to the most stringent of the applicable codes.
   2. Provide the quality identified within these Specifications and Drawings when codes, standards, regulations, etc. allow Work of lesser quality or extent. The Contract Documents address the minimum requirements for construction.

D. Drawings
   1. Follow the general layout shown on the Drawings except where other Work may conflict with the Drawings.
   2. Drawings for the Work within this Division are essentially diagrammatic within the constraints of the symbology applied.
3. The Drawings do not fully represent the entire installation for the Communications System. Drawings indicate the general route for the cables and the location of outlets. The Drawings might not expressly show every conduit, sleeve, hanger, etc., but a complete system is required.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Delivery
1. Do not deliver products to the site until protected storage space is available.
2. Coordinate materials delivery with installation schedule to minimize storage time at jobsite.
3. Deliver materials in manufacturer's original, unopened, undamaged packaging and containers with identification labels (name of the manufacturer, product name and number, type, grade, UL classification, etc.) intact.
4. Immediately replace equipment damaged during shipping at no cost to the Owner, so as not to impact the construction schedule.

B. Storage and Protection
1. Store materials in clean, dry, ventilated space free from temperature and humidity conditions (as recommended by manufacturer) and protected from exposure to harmful weather conditions.
2. Comply with manufacturer's storage requirements for each product. Comply with recommended procedures, precautions or remedies as described in the Material Safety Data Sheets (MSDS) as applicable.
3. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
4. Storage outdoors covered by rainproof material is not acceptable.
5. Provide heat where required to prevent condensation or temperature related damage.

C. Handling
1. Handle materials and equipment in accordance with manufacturer's written instructions. Handle with care to prevent damage, breakage, denting, and scoring.
2. Do not install damaged materials and equipment. Replace damaged equipment at no cost to the Owner.

1.08 SCHEDULING

A. Unless otherwise specified, the construction schedules of the Sections within Division 27 may be combined into a single, overall schedule.

B. Do not proceed without written approval from the Owner or Owner’s Representative for schedule of this Work.

1.09 PROJECT MANAGEMENT AND COORDINATION

A. Project Management and Coordination Services
1. Provide a project manager for the duration of the project to coordinate this Work with other trades. Coordination services, procedures and documentation responsibility include, but are not limited to, the items listed in this section.
2. BIM Model Coordination:
   a. Resolve conflicts with other trades during design assist phase of the projects. Obtain the assistance/approval of the engineer where the design deviates substantially from the contract drawings.

B. Concurrent Installation
1. The network will be installed concurrent with the work of Division 27. Coordinate your work with the Owner's/network integrator’s work. For example, coordinate scope and dates for rack and cabling (terminations) readiness to allow the network integrator to plan and schedule installation of the network equipment (for example, access switches).

C. Role of the Engineer
   1. The Owner has retained the Engineer’s services through construction. During construction, the Engineer will work with and assist the Contractor as follows:
      a. Review product data and shop drawings submittals for general compliance with the contract drawings and specifications.
      b. Provide interpretation and clarification of project contract documents
      c. Reply to (and ‘process’) relevant Requests for Information (RFIs)
      d. Review changes as they arise, and confirm that the proposed solutions maintain the intended functionality of the system.
      e. Interpret field problems for Owner, and translate between Owner and Construction Team.
      f. Review the testing procedures to confirm compliance with industry-accepted practices.
      g. Observe the work for general compliance with the Contract Documents and to ensure that the installation meets the design intent of the system, and report progress to the Owner.

D. Use of CAD Files
   1. Should the Contractor require the Engineer’s CAD files to produce shop drawings and/or as-built drawings, the Engineer requires the Contractor sign a CAD files release agreement.

1.010 WARRANTY

A. Warranty products and labor provided will, under normal use and service, be free from defects and faulty workmanship for period of 5 years from the date of acceptance. During the warranty period the entire system shall be kept in operating condition at no additional material or labor costs to the Owner.

B. Render service within two business days of system failure notification. Note deviations or improvements to this service at the time of bid and obtain written acceptance from the Owner, or Owner’s Representative.

C. Manufacturers of the major system components shall maintain a replacement parts department and provide testing equipment when needed. Provide complete replacement parts within two business days during the warranty period.

D. Conformance to certain government standards on quality assurance may be required for some applications outlined in these specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials used shall present no environmental or toxicological hazards as defined by current industry standards and shall comply with OSHA and EPA standards, other applicable federal, state, and local laws.
B. Product numbers are subject to change by the manufacturer without notification. In the event a product number is invalid or conflicts with the written description, notify the Engineer in writing prior to ordering the material and performing installation work.

2.02 PRODUCT SUBMITTAL AT TIME OF BID

A. At the time of bid, include a list of major products in the Contract documenting the intended cabling system solution. Examples of major products may include: horizontal cable, modular jacks, faceplates, modular patch panels, backbone cable, termination block systems, fiber connectors, fiber patch panels.

2.03 SUBSTITUTIONS

A. Conform to the general requirements and procedure outlined in Division 01 in the Request For Substitution.

B. Only one substitution allowed for each product specified.

C. Where products are noted as "or equal", a product of equivalent design, construction, and performance will be considered. Submit product data – catalog cuts, product information, and pertinent test data – required to substantiate that the product is in fact equivalent to that specified. The burden of proof that the substituted product is equivalent to the specified product rests with the Contractor. Whenever material, process or equipment is specified in accordance with an industry specification (ANSI, TIA, etc), UL rating, or other association standard, present an affidavit from the manufacturer certifying that the product complies with the particular standard specification. When requested by the Engineer, submit supporting test data to substantiate compliance.

D. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility and appearance. Materials, processes or equipment that, in the opinion of the Engineer, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when “or equal” follows the manufacturers' names or model number(s).

E. When the Engineer accepts a substitution in writing, it is with the understanding that the Contractor guarantees the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction according to contract documents. Do not provide substituted material, processes, or equipment without written authorization from the Engineer. Assumptions on the acceptability of a proposed substitution, prior to acceptance by the Engineer, are at the sole risk of the Contractor.

F. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the work, or from provisions of the specifications.

G. Pay expenses, without additional charge to the Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on self, subcontractor's or other Contractor's work.

PART 3 - EXECUTION

3.01 PERMITS AND INSPECTIONS
A. Obtain and pay for permits and inspections required for the work.

B. Furnish materials and execute workmanship for this work in conformance with applicable legal and code requirements.

C. Perform tests required herein, or as may be reasonably required to demonstrate conformance with the Specifications or with the requirements of legal authority having jurisdiction.

D. Arrange and pay for review/inspection from compliance officials responsible for enforcement of applicable codes and regulations to establish that the work is in compliance with requirements of reference codes indicated herein.

3.02 EXAMINATION

A. Verify existing conditions, stated under other sections, are acceptable for installation in accordance with manufacturer's instructions.

3.03 FIELD QUALITY CONTROL

A. Staffing: Provide a qualified foreman to supervise the crew performing the work and who is present at the job site at times work is being performed.

B. Construction Meetings: Participate in construction coordination meetings throughout the course of construction to review the progress and to resolve issues and conflicts. Prepare and distribute meeting agenda for telecommunication issues prior to, and meeting notes after meetings, in a format acceptable to the Owner. Publish meeting notes within 3 business days following the meeting.

C. Scheduling: Perform the work within the approved construction schedule. Keep the construction schedule current, based on the results of the construction meetings. At minimum, schedule shall document critical due dates, tasks, and milestones. Submit revised schedules for approval within 3 business days whenever there are modifications.

D. Inspection: Inspect the work after installation. Keep areas of work accessible and notify code authorities, or designated inspectors, of work completion released for inspection. Document completion and inspection as required.

3.04 INSTALLATION

A. Complete work in a neat, high-quality manner, relative to common industry practices, and in accordance to NECA “Standard of Installation”.

B. Complete work in conformance to applicable federal, state and local codes, and telephone standards.

C. Coordinate the entire installation throughout the construction team (general contractor and subcontractors).

D. Manufacturer's Instructions:
   1. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.
2. Maintain jobsite file of Material Safety Data Sheets (MSDS) for each product delivered to jobsite packaged with an MSDS.

E. Adjusting:
1. Make changes and revisions to the system to optimize operation for final use.
2. Make changes to the system such that defects in workmanship are corrected and cables and the associated termination hardware pass the minimum test requirements.

F. Protection
1. Protect installed products and finish surfaces from damage during construction.

G. Repair/Restoration
1. Replace or repair work completed by others that you deface or destroy. Pay the full cost of this repair/replacement.
2. Repair defects prior to system acceptance.

3.05 CLEANING

A. Remove temporary coverings and protection of adjacent work areas. Remove unused, excess, and left over products, debris, spills, or other excess materials. Remove installation equipment.

B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.

C. Repair or replace damaged installed products.

D. Legally dispose of debris.

E. Clean installed products in accordance with manufacturer's instructions prior to Owner's, or Owner’s Representative’s, final punch walk.

3.06 FINAL INSPECTION AND CERTIFICATION

A. Punch Walks and Punch Lists
1. Punching the Work of individual Sections of Division 27 may be combined.
2. Execute a punch walk with the Engineer and the Owner or Owner's Representative to observe Work.
3. Develop a punch list for items needing correction. Issue this punch list to Engineer.
4. Correct the Work as noted on punch list.
5. Execute follow up punch walk with the Engineer and the Owner or Owner’s Representative to verify punch list items have been corrected.

B. System Acceptance
1. Complete corrections (punch list items) prior to submitting acceptance certificate.
2. On completion of the acceptance test, submit system acceptance certificate to the Owner or Owner’s Representative requesting their signature and return of the certificate. Issue copies of the signed certificate back to the Owner or Owner’s Representative with copy to the Engineer.

C. Training
1. After acceptance, schedule a time convenient with the Owner, or Owner's Representative, for instruction in the configuration, operation, and maintenance of the system.
2. Provide 2 hours, minimum, UON in individual specification sections of on-site training by a factory-trained representative. Document dates and times of training, and submit a “sign in” sheet for individuals trained, as part of the close out documentation.
SECTION 27 05 26 - COMMUNICATIONS GROUNDING AND BONDING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Communications Grounding Backbone and bonding of communications infrastructure and equipment to Communications Grounding Backbone.

B. Related Sections
   1. Comply with the Related Sections requirements of Section 27 00 00.

1.02 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

B. In particular or addition to the codes and standards listed in Section 27 00 00, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
   1. NFPA 70, “National Electrical Code”, particularly the following Articles:
      a. Article 250: Grounding
      b. Article 770: Optical Fiber Cables and Raceways
      c. Article 800: Communications Systems
      d. Article 810: Radio and Television Equipment
      e. Article 820: Community Antenna Television and Radio Distribution Systems
   2. Underwriters Laboratories, Inc. (UL) UL 467: Grounding and Bonding Equipment
   3. Electronic Industries Association/Telecommunication Industry Association:
   4. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1.03 DEFINITIONS

A. Definitions as described in Section 270000 shall apply to this section.
B. In addition to those Definitions of Section 270000, the following list of terms as used in this specification defined as follows:
1. “BCT”: Bonding Conductor for Telecommunications
2. “CM” and “cmil”: Circular Millionths of an inch
3. “GE”: Grounding Equalizer Conductor
4. “MBRGB”: Main Building Reference Grounding Busbar
5. “TBB”: Telecommunications Bonding Backbone
6. “TBC”: Telecommunications Bonding Conductor
7. “TGB”: Telecommunication Grounding Busbar
8. "THHN": Thermoplastic High Heat-resistant Nylon-coated
9. “TMGB”: Telecommunication Main Grounding Busbar

1.04 SYSTEM DESCRIPTION

A. Base Bid Work: The Work under this section includes furnishing materials, installation, and coordination through the General Contractor with other trades for a Communications Grounding Backbone and for bonding of telecommunications equipment and apparatus to the Communications Grounding Backbone.

B. Communications Grounding Backbone System: The Communications Grounding Backbone System contains grounding busbars, grounding conductors, bonding conductors, and connecting devices (including but not limited to pressure connectors, lugs, clamps, or exothermic welds). These components, upon completion of installation and testing, shall provide the means of a low impedance path to earth for unintentional and/or stray voltages or spurious signals present on telecommunications media and equipment. The Communications Grounding Backbone System will consist of the following aspects in addition to the grounding requirements in the electrical plans.

1. TMGB: Locate the TMGB in the EF with the following connections:
   a. MBRGB, via BCT
   b. Each TBB
   c. Ground bushings installed on each entrance conduit opening within the space, via TBC
   d. Overhead cable support within the space, via TBC
   e. Dedicated power panel’s ACEG within the space serving communication equipment, via TBC
   f. Metallic pathways (conduits, surface raceway, etc.) within the space, via TBC

2. TBB: TBB(s) are the primary bonding conductor between the TMGB and other TGBs provided throughout a single building. The length of TBBs shall not exceed 500 feet. The TBB shall route from the EF through each of the TRs bonding each of the TGBs to the TMGB. Maintain TBB continuity and do not break continuity in order to bond to a TGB.

3. GE: GE(s) are bonding conductors between TGBs (or other elements of the grounding backbone) on a common floor. The length of GEs shall not exceed 500 feet. One GE shall occur every three floors. Maintain GE continuity.

4. TGB: Locate the TGB in each TR with the following connections:
   a. TBB
b. Building steel, via TBC

c. Each entrance conduit into the space, via TBC and ground bushings

d. Overhead cable support within the space, via TBC

e. Panelboard’s ACEG within the space serving telecommunication equipment, via TBC

f. Metallic pathways (conduits, surface raceway, etc.) within the space, via TBC

C. Performance Criteria for the Grounding Backbone:

1. Resistance from any point of the communication grounding backbone system to the ground electrode and to earth shall not exceed 20 Ohms.

2. Field test resistance and document, both electronically and printed, measured values.

D. Bonding: Bonding consists of TBCs within telecommunications rooms from the TMGB and TGBs to the following components:

1. Rack bay
2. Overhead cable support and vertical cable support
3. Wall-mounted termination equipment
4. Conduit ground bushings
5. Exit pathways
6. Bonding jumpers between basketway, cable runway, and cable tray joints & splices, and between basketway/cable runway/tray and equipment racks. Note: Bonding jumpers are not required if tray splices are UL listed as a grounding conductor.

E. Conductor Gauge Criteria:

1. Size BCT as the greater of either 2,000 cmil per linear foot up to 3/0 AWG or the largest TBB.

2. Size TBB, GE, and TBCs as 6 AWG minimum, then as 2,000 cmil per linear foot up to 3/0 AWG.

1.05 SUBMITTALS

A. Comply with Submittal procedural, quantity, and format requirements of Section 27 00 00.

B. Submittal Requirements at Start of Construction:

1. Product Data Submittal
2. Shop Drawing Submittal(s), if the Contractor’s installation intent differs from the Contract Documents or the design intent

C. Substitutions

1. Requests for substitutions shall conform to the general requirements and procedure outlined in Section 27 00 00.
D. Submittal Requirements at Closeout: Submit to the Owner at the time of project
closeout the following and before certificate of final payment is issued.
1. Test Report: Submit computer-generated test records of measured resistance values
for inclusion into the Operation and Maintenance Manual.
2. As-Built Drawings, consisting primarily of the Communications Grounding
Backbone (not necessarily each bonded component or apparatus)

1.06 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 27 00 00.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 27 00 00.

1.08 WARRANTY

A. Warrant Work to perform as described within this Section for a period of 5 years.
Correct deficiencies within 24 hours of notification.

PART 2 - PRODUCTS

2.01 GROUNDING AND BONDING CONDUCTORS

A. Application: Suitable for indoor installation as a BCT, TBB, GE, and/or TBC.

B. Type: THHN (or THWN)

C. Conductor: 1/C, annealed copper, stranded

D. Gauge: Refer to conductor sizing criteria.

E. Insulation: thermoplastic/nylon or similar, green in color

F. Flame Resistance: Meet the flame resistance requirements of IEEE 383, CSA FT-4 and
UL VW-1.

G. Print on the Insulation: insulation grade, conductor gauge, and applicable UL jacket
listings.
2.02 SPLICE

A. Application: High-pressure compression type connectors shall be used for cable-to-cable and cable-to-ground rod connections.

B. Manufacturers:
   1. Panduit
      a. #HTCT250-250-1; “H-type” compression splice for #2 – 250MCM AWG
   2. Thomas & Betts
      a. #53000 series
   3. Or equal

2.03 CONNECTOR – “PARALLEL” TAP

A. Application: H-type thick wall compression tap, for making conductor–to–conductor (e.g., TBB-to-TBC) permanent connection (pig tailing, tapping, or splicing). Connectors shall be UL Listed.

B. Manufacturers:
   1. Panduit
      a. #HTCT2-2-1; “H-type” compression tap, run = #6-#2, tap = #2-#6.
      b. #HTCT250-2-1; “H-type” compression tap, run = #2-250MCM, tap = #6-#2
   2. Or equal

2.04 CONNECTOR – “C” TAP

A. Application: C-type copper thick wall compression tap, for making conductor–to–conductor (e.g., TBB-to-TBC) permanent connection (pigtailing, tapping, or splicing). Connectors shall be UL Listed.

B. Manufacturer:
   1. Panduit
      a. #CTAPF4-12-C; CTAP for #6 AWG run –to– #6 AWG tap
      b. #CTAPF2-12-C; CTAP for #2 AWG run –to– #6 AWG tap
      c. #CTAPF1/0-12-L; CTAP for 1/0 AWG run –to– #6 AWG tap
      d. #CTAPF2/0-12-Q; CTAP for 2/0 AWG run –to– #6 AWG tap
      e. #CTAPF3/0-12-Q; CTAP for 3/0 AWG run –to– #6 AWG tap
   2. Or equal

2.05 GROUNDING BUSBAR - TINNED

A. General: Busbar shall be UL listed.
B. Standards: Compliant to ANSI-J-607-A

C. Material: Solid copper, tinned cladding

D. Holes: Predrilled, compatible with standard NEMA bolt hole sizing and spacing and with ANSI-J-607-A recommendations for 2-hole lugs.

E. Mounting: Wall-mounted with standoffs. Standoffs shall insulate busbar from the mounting substrate.

F. Manufacturer:
   1. Panduit
      a. # GB4B0624TPI-1; busbar, 20”L x 4”W x ¼”T, TMGB hole pattern
   2. Or equal

2.06 CONNECTION TO STRUCTURAL STEEL

A. Application: Exothermic welds shall be used for cable-to-cable, cable-to-ground rod, and cable-to-structural steel.

B. Manufacturers:
   1. Cadweld
      a. Each particular type of weld shall use a kit unique to that type of weld
   2. Or equal

2.07 CONNECTOR – COMPRESSION LUG

A. Application: Conductor-to-busbar and/or –rack (or other flat surfaces) connection

B. Type: compression lug, standard or long barrel, two-hole (1/4 inch diameter 5/8 inch on center)

C. Manufacturers:
   1. Panduit
      a. #LCC6-14JAW-L; for 6 AWG conductor
      b. #LCC4-14ADW-L; for 4 AWG conductor
      c. #LCC2-14AW-Q; for 2 AWG conductor
      d. #LCC1-14AW-E; for 1 AWG conductor
      e. #LCC1/0-14AW-X; for 1/0 AWG conductor
      f. #LCC2/0-14AW-X; for 2/0 AWG conductor
   2. Or equal
2.08 CONNECTOR – SPLIT-BOLT, MECHANICAL TYPE

A. Application: Conductor-to-conductor (or other round component) connection

B. Type: split-bolt mechanical connector, for #6 to #3 conductor

C. Material: high-strength copper alloy

D. Manufacturers:
   1. Panduit
      a. #SBC3-C
   2. Or equal

2.09 GROUND BUSHING

A. Plated malleable iron body with 150 degree Centigrade molded plastic insulating throat and lay-in grounding lug.

B. Manufacturers:
   1. OZ/Gedney BLG
   2. Thomas & Betts #TIGB series
   3. Or equal.

2.10 LABELS

A. Labels for Busbars
   1. Labels shall be machine-printable (such as by a laser printer or hand-held printer)
   2. Printable Area: 2” x 0.5”, minimum.
   4. Manufacturer:
      a. Panduit
         1) #C200X100FJJ; laser/ink jet labels for busbars, white
      b. Or equal

B. Labels for Conductors
   1. Labels shall be machine-printable (such as by a laser printer or hand-held printer)
   2. Labels shall be adhesive-backed and have a self-laminating feature.
   3. Printable Area: 1 inch wide x 0.5 inch high, minimum
   5. Manufacturer:
      a. Panduit
         1) #S100X150YAJ; laser/ink jet labels for wire diameters 0.16” (#6) - 0.32” (#1/0), white
2) # S100X225YAJ; laser/ink jet labels for wire diameters 0.24” (#2) - 0.48” (#3/0), white
   b. Or equal

2.11 MISCELLANEOUS

A. Wire Clamp
   1. Material: nylon, UV stabilized.
   2. Color: black
   3. Size: 0.25” holding diameter for 6 AWG; or size as required based on conductor size.
   4. Manufacturer:
      a. Richco Inc.
      1) #N4B-BLK
      b. Or equal

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with the Execution requirements of Section 27 00 00.

B. Work shall comply with the International Building Code, International Fire Code, National Electrical Code, UL 467, and ANSI-J-607-A standards, as well as local codes that may specify additional grounding and/or bonding requirements. If discrepancies between codes and/or standards arise, codes shall prevail, and then the more stringent requirement shall prevail, and as directed by the AHJ.

C. Install components to manufacturer’s instructions and recommendations and as required per UL listing.

D. Identify grounding and bonding conductors and components according to local codes.

E. Terminations must be accessible for inspection and maintenance during the life of the system.

3.02 EXAMINATION AND PREPARATION

A. Prior to the start of this section’s work, examine pathways and communications rooms for completeness, compatibility with the work of this section, and readiness for connections with the work of this section.
3.03 INSTALLATION

A. BCT, TBB, and GE Conductors
   1. Install BCT, TBB, and GE conductors in a manner to protect them from physical
damage.
   2. When routing BCT, TBB, or GE conductors through metallic conduit 3 feet or
longer, bond the conductor to the conduit at both ends using a #6 AWG bonding
conductor as a pigtail, an irreversible connection (preferably exothermic weld) for
the conductor-to-pigtail connection, and insulated ground bushings at the conduit
ends.
   3. Install the BCT, TBB, or GE conductor without splices.
      a. In the event that a splice is necessary, notify the Project Manager in writing.
         Do not proceed with splicing work until the Project Manager has
         accepted in writing the installation of a splice.
      b. Locate the splice in a telecommunications space and ensure accessibility.
      c. Perform the splice using an exothermic weld and an irreversible compression-
type connector.
   4. Connect grounding conductors to structural steel using exothermic welds. Each
particular type of weld shall use a kit unique to that type of weld.

B. TMGB and TGB Busbars
   1. Mount busbars using insulating standoffs. If not noted on drawings, install busbars
onto wall at 24 inches AFF located within 5 feet of backbone pathways or rack bay.

C. Panelboard Bonding
   1. Where a panelboard is located in the same communications room as a TMGB/TGB
and serves that room, provide TBC between busbar and that panelboard’s
Alternating Current Equipment Ground (ACEG) bus (where equipped) or the
enclosure.

D. Bonding
   1. Provide TBC and appropriate grounding hardware between the nearest TMGB/TGB
and the equipment racks / rack bay, overhead cable support, vertical cable support,
telecommunication conduits, primary pathways that enter/exit the room (if
applicable), and other metallic telecommunication infrastructure components.
   2. Minimum size: #6. If longer than 100 feet, size TBCs based on length using 1000
cmil per foot, up to 2/0 AWG.
   3. Install TBCs in a manner that will protect them from physical and mechanical
damage.
   4. Routing:
      a. Route TBCs in the shortest possible path, using right angles for turns and
         routed
         parallel to building lines. Route on outside edges of wall
         plywood. Do not cut across the middle of the plywood taking space away
         from other equipment or components.
      b. Utilize a minimum 1-foot bend radius.
   5. Connection to TMGB/TGBs:
a. Thoroughly clean busbars prior to attaching connectors to the busbar.
b. Fasten connectors (e.g., lugs) to the busbar using matching size cadmium bronze bolt, flat washer Belleville washer, and nut. Torque hardware set.

6. Rack Bay Bonding
   a. Provide bonding the rack bay.
   b. Bond equipment racks, frames, frame bays, cabinets, server racks, and other similar support systems located within the same room or space as the TMGB/TGB to the busbar.
   c. Use approved connectors for TBC-to-rack, -frame, and -cabinet connections.
   d. Rack bays may be bonded in series using either of the following configurations:
      1) Series: Provide a TBC from the TGB to the rack closest to the busbar; then provide a TBC to the other racks in the rack bay in series using a common lug/connection per rack. The rack shall not be used as a ‘conductor’ in the series connection.
      2) String: Provide one ‘main’ TBC from the TGB along the length of the rack bay, and provide a pigtail from the ‘main’ TBC per rack. Use an irreversible connection (such as “C” tap) for the ‘main’-to-pigtail connection.

7. Overhead and Vertical Cable Support Bonding
   a. Bond overhead and vertical cable support located within the same room or space as the TMGB/TGB to the busbar.
   b. Provide either UL listed connectors and splice plates or UL Listed bonding strap to bond sections of overhead cable support for ground continuity. This requirement applies to cable tray, basketway, and runway sections within a single telecommunication room.

8. Termination Field Bonding
   a. Provide bonding the termination blocks.
   b. Bond termination blocks to the TMGB/TGB within the same room or space. Termination blocks may be bonded in series, with the block closest to the TMGB/TGB bonded to the busbar.

9. Metallic Raceway Bonding
   a. If TBC routes through conduit longer than 1 meter, bond metallic conduit to conductor at both ends.
   b. Bond metallic raceways for telecommunications cabling (conduit, cable tray, cable runway, and other metallic telecommunication infrastructure components) located within the same room or space as the TMGB or TGB to the nearest telecommunication grounding busbar.

3.04 LABELING

A. General Requirements
   1. Labeling, identifier assignment, and label colors shall conform to TIA/EIA-606-A Administration Standard and as approved by the Engineer and Owner before installation.
   2. Permanently label TBCs. Affix label as close as practical to each end of the conductor.
B. Label Format
   1. Provide permanent labels with machine-generated text; hand written labels will not
      be accepted.
   2. Labels on TBCs shall fully wrap around conductors with a self-laminating feature
      to provide permanent marking.

C. Identifier Assignment
   1. Separate label fields of the identifier with a hyphen.
   2. Assign identifiers according to current practice and as approved by the Engineer
      and Owner before installation.
   3. BCT and TBB
      a. First field: “BCT” or “TBB” (the conductor type).
      b. Second field: a unique sequential number, for example, “01”.
      c. Example: “TBB-01”
   4. GE
      a. First field: “GE” (the conductor type).
      b. Second field: floor number, for example, “06”.
      c. Third field: a unique sequential number, for example, “01”.
      d. Example: “GE-06-01”
   5. Ground Busbars
      a. First field: “TMBG” or “TGB” (the busbar type).
      b. Second field: the room’s identity (TR identifier’s suffix) where the busbar is
         installed; for example, “3A2.1”.
      c. Example: “TGB-3A2.1”
   6. TBC:
      a. First field: “TBC” (the bonding conductor type).
      b. Second field: The room identity where TBC exists; for example: “A1.1”.
      c. Third field: A unique sequential number; for example: “01”, “02”, etc.
      d. Fourth field: describe the device, equipment, component, or raceway being
         bonded.
      e. Example: “TBC-A1.1-01 (RACK BAY)”

3.05 GROUNDING BACKBONE RESISTIVITY MEASUREMENT

A. Measure ground resistance from the furthest ground busbar to earth; record
   measurement. Provide additional grounding electrodes, bonding, and other elements as
   required to comply with resistance limits specified in this Section.

B. Submit computer-generated records of measured resistance values to the Engineer and
   Owner for approval and for inclusion into the Operation and Maintenance Manual.

3.06 FINAL INSPECTION AND CERTIFICATION

A. Punch the Work of this Section compliant to the requirements of Section 27 00 00.
   Punching the Work of this Section may be combined with punching the rooms.
B. Comply with system acceptance and certification requirements of Section 27 00 00.

END OF SECTION 27 05 26
SECTION 27 05 28 - COMMUNICATIONS BUILDING PATHWAYS

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes pathway systems for low voltage cabling and wiring.

B. Related Sections
   1. Comply with related Sections 27 00 00 and 26 05 00.
   2. Section 26 05 26 Grounding and Bonding for Electrical Systems
   3. Section 26 05 33 Raceway and Boxes for Electrical Systems

1.02 REFERENCES

A. Comply with the latest edition of the following applicable Specifications and standards except as otherwise indicated or specified:

B. Federal Specifications (FS):
   1. FS WW-C-563: Electrical Metallic Tubing
   2. FS WW-C-566: Specification for Flexible Metal Conduit

C. American National Standards Institute, Inc. (ANSI):
   1. ANSI C80.3: Electrical Metallic Tubing, Zinc Coated
   2. ANSI/NEMA OS-1 Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports

D. Underwriters Laboratories, Inc. (UL):
   1. UL 514B: Conduit, Tubing and Cable Fittings
   2. UL 635: Insulating Bushings
   3. UL 797: Electrical Metallic Tubing – Steel
   4. UL 50: Enclosures for Electrical Equipment
   5. UL 514A: Metallic Outlet Boxes

E. ASTM International:
   1. ASTM A123 – Specifications for Zinc (Hot Galvanized) Coatings on Iron and Steel
   2. ASTM A510 – Specifications for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel
   3. ASTM A525 – General Requirements for Steel Sheet, Zinc-Coated Galvanized by the Hot-Dip Process
4. ASTM B633 – Specifications for Electrodeposited Coatings of Zinc on Iron and Steel
5. ASTM A653 – Specifications for Steel Sheet, Zinc-Coated (Galvanized) by Hot Dip Process
6. ASTM A591 – Specifications for Electrodepositing Coatings of Zinc on steel wire or sheets

F. National Electrical Manufacturer Association (NEMA)
   1. NEMA VE 1 – Cable Tray Systems
   2. NEMA VE 2-2000 – Cable Tray Installation Guidelines

1.03 DEFINITIONS

A. Definitions as described in Section 27 00 00 shall apply to this section.

B. In addition to those Definitions of Section 27 00 00, the following list of terms as used in this specification defined as follows:
   1. “Cable Hanger”: A metal, most often steel, or fabric cable support device often shaped (section view) similar to the letter J. The device is available in different sizes supporting different quantities of cables, and is also available with different attachment hardware to be supported by different methods (e.g., wire support, beam flange clip, etc.).
   2. “Flat Bar”: Custom cable support product manufactured by CEAS, Inc.
   3. “Ladder Cable Tray”: A continuous, rigid, aluminum cable support and management system. Available in different sizes supporting different quantities of cables.
   4. “Wire Basket Cable Tray”: A continuous, rigid, welded steel wire mesh cable support and management system. Available in different sizes supporting different quantities of cables, and is also available with different attachment hardware to be supported by different methods.

1.04 SYSTEM DESCRIPTION

A. Base Bid Work

B. The work under this section shall include the planning and coordination (and other trades) of telecommunications system pathways, the furnishing of necessary materials, and the labor & associated services required to install telecommunications pathways.

C. All pathways should be installed in accordance with the most recent ANSI/TIA, NEC and the BICSI TDMM specifications.

D. The Telecommunications Pathways consist of the following subsystems:
1. Cable Hangers  
2. Electrical metallic tubing and fittings.  
3. Miscellaneous conduit fittings and products.  
4. Wall and ceiling outlet boxes.  
5. Pull and junction boxes.

1.05 SUBMITTALS

A. Comply with Submittal procedural, quantity, and format requirements of Section 27 00 00.

B. Submittal Requirements at Start of Construction:

C. Product Data Submittal

D. Shop Drawings Submittal: Consisting of proposed changes to pathway route plans.

E. Submittal Requirements at Close Out:

F. As-Built Drawings – primarily of the Communications Building Pathways.

G. Substitutions

H. Requests for substitutions shall conform to the general requirements and procedure outlined in Section 27 00 00.

1.06 QUALITY ASSURANCE

A. Comply with the quality assurance requirements of Section 27 00 00.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 27 0000.

1.08 WARRANTY

A. Warrant Work to perform as described within this Section for a period of 5 years. Correct deficiencies within 24 hours of notification.
PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. B-Line
B. CEAS
C. STI
D. RANDL
E. FSR
F. Wiremold
G. Panduit
H. Chatsworth
I. Or equal.

2.02 CONDUIT – EMT TYPE

A. EMT conduit shall conform to ANSI C80.3 specifications and shall meet UL requirements.

B. EMT conduit shall be formed of cold rolled strip steel, electrical-resistance welded continuously along the longitudinal seam and hot dip galvanized after welding.

C. Manufacturers:
   1. Alflex Corp
   2. Allied Tube and Conduit Co
   3. Anaconda
   4. Appleton Electric Co
   5. Occidental Coating Co. (OCAL)
   6. OZ/Gedney
   7. Spring City Electrical Manufacturing Co
   8. Thomas & Betts Corp
   9. Triangle PWC, Inc
   10. Western Tube and Conduit Corp
2.03 CONDUIT – COUPLERS

A. EMT
   1. Set screw type couplings: Electroplated, steel or cast malleable iron, UL Listed concrete tight. Use set screw type couplings with four setscrews each of conduit sizes over 2 inches. Setscrews shall be of case hardened steel with hex head and cup point to firmly seat in wall of conduit for positive grounding.
   2. Raintight couplings: Electroplate steel or cast malleable iron; UL Listed raintight and concrete tight, using gland and ring compression type construction.

2.04 CONDUIT – STRAPS

A. One-Hole and Two-Hole Straps
   1. Application: Strap, used in conjunction ion with fasteners, to hold conduit in place.
   2. Material: steel, malleable iron, or high tensile strength plastic straps (for inside building use) with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.

B. Channel Straps
   1. Application: Strap, used in conjunction ion with channel and (as applicable) fasteners, to hold conduit in place.
   2. Material: steel, malleable iron, or high tensile strength plastic straps (for inside building use) with malleable iron clamp-back spacer for surface mounted wall and ceiling applications.

2.05 CONDUIT – MISCELLANEOUS FITTINGS AND PRODUCTS

A. Watertight conduit entrance seals: Steel or cast malleable iron bodies and pressure clamps with PVC sleeve, neoprene sealing grommets and PVC coated steel pressure rings. Fittings shall be supplied with neoprene sealing rings between the body and PVC sleeve.

B. Watertight cable sealing bushings: One piece, compression molded sealing ring with PVC coated steel pressure disks, stainless steel sealing screws and zinc plated cast malleable iron locking collar.

C. Expansion fittings: Multi-piece unit comprised of a hot dip galvanized malleable iron or steel body and outside pressure bussing designed to allow a maximum of 4" conduit movement (2" in either direction). Furnish with external braid tinned copper bonding jumper. Unit shall be UL Listed for wet or dry locations.
D. Expansion/deflection couplings: Multi-piece unit comprised of a neoprene sleeve with internal flexible tinned copper braid attached to bronze end couplings with stainless steel bands. Coupling shall accommodate .75-inch deflection, expansion, or contraction in any direction, and allow 30-degree angular deflections. Flexible, corrosion-resistant, watertight, moisture and heat resistant molded rubber jacket and stainless steel jacket clamps. Unit shall comply with UL467 and UL514B. Manufacturer shall be OZ/Gedney Type DX, Steel City Type EDF or equal.

E. Fire rated penetration seals:
1. UL building materials directory classified.
2. Conduit penetrations in fire rated separation shall be sealed with a UL classified fill, void or cavity material.
3. The fire rated sealant material shall be the product best suited for each type of penetration, and may be a caulk, putty, composite sheet or wrap/strip.

F. Standard products not herein specified:
1. Provide listing of standard electrical conduit hardware and fittings not herein specified for approval prior to use or installation, i.e. locknuts, bushings, etc.
2. Listing shall include manufacturers name, part numbers, and a written description of the item indicating type of material and construction.
3. Miscellaneous components shall be equal in quality, material, and construction to similar items herein specified.

2.06 HORIZONTAL MANAGEMENT PANEL

A. Application: Suitable for installation into equipment rack for horizontal cord management. The horizontal management panel shall match (and fully integrate with) the vertical management sections.

B. The horizontal management panel shall be single-sided.

C. Size: 1U and 2U high by 19” mounting wide.

D. Color: black (guides and cover).

E. Manufacturer:
1. Chatsworth
   a. NM-1 - 1 RU 1-3/4” Horizontal Cable Manger
   b. NM-2 - 2 RU 3-1/2” Horizontal Cable Manger
   c. NM-3 - 3 RU 5-1/4” Horizontal Cable Manger
   d. NM-4 - 4 RU 4”” Horizontal Cable Manger, Front only
2. Or Panduit Equal
2.07 CABLE HANGERS

A. Application: Suitable for indoor installation within ceiling space for the support of communications cables.

B. Manufacturer:
   1. CEAS Figure 200 Series Low Voltage Supports
   2. Or equal

2.08 FLAT BAR

A. Application: Suitable for indoor installation within ceiling space for the support of communications cables.

B. Manufacturer:
   1. CEAS Figure 224 Low Voltage Support
   2. Or equal (no known equal)

2.09 FIRE RATED PENETRATION ASSEMBLY

A. Penetration assemblies shall be UL Listed for the application.

B. Penetration assemblies shall meet or exceed the rating of the wall (or floor) being penetrated.

C. Manufacturer
   1. STI EZ-Path 44 Series
   2. Or equal (no known equal)

2.10 FIRE RATED /SMOKE BARRIER PENETRATION ASSEMBLY

A. Penetration assemblies shall be UL Listed for the application.

B. Penetration assemblies shall meet or exceed the rating of the wall (or floor) being penetrated.

C. Manufacturer
   1. STI EZ-Path 33 Series
   2. Or equal (no known equal)
2.11 OUTLET BOXES

A. Telecommunications outlet box shall be one-piece die formed or drawn steel, knockout type box of size and configuration indicated on the drawings.

B. Box size: 5-inch square by 2-7/8 inch deep shall be minimum

C. Listing: C ETL US

D. Manufacturer
   1. RANDL Industries
      a. TB-55057 Telecommunications Bracket Outlet Box
      b. TB-55017 Telecommunications Outlet Box
      c. TB-55058 Telecommunications Bracket Outlet Box
      d. TB-55018 Telecommunications Outlet Box
   2. Or equal

PART 3 - EXECUTION

3.01 EXAMINATION

A. Contractor shall thoroughly examine Project site conditions for acceptance of conduit system installation to verify conformance with Manufacturer and Specification tolerances. Do not commence with installation until all conditions are made satisfactory.

3.02 APPLICATION

A. Wire basket cable tray: Not used (J-hooks)

B. Ladder cable tray: Not used (J-hooks)

C. Electrical metallic tubing (EMT): Shall be used concealed for interior low voltage cables where run above non-accessible ceilings, in stud walls, furred spaces and crawl spaces.

3.03 INSTALLATION

A. Support pathway systems per manufacturer requirements or as required by structural calculations.
B. The Contractor shall provide written documentation outlining and cable or pathway that does not meet requirement in the form of an RFI.

C. Interface with Other Work:
   1. Verify route prior to installation.
   2. Coordinate the installation of the cable pathway system with other trades.
   3. Do not support from ductwork, piping, or other equipment hangers.
   4. Install pathways so that cables do not touch or rest on other any other systems.

D. Installation clearances:
   1. Install systems to maintain a minimum clearance of four (4) feet from any motor.
   2. Install systems a minimum of six inches from fluorescent light fixtures, or other EMI sources. Power cables in EMT are acceptable.
   3. Refer to drawings for side and top access clearance requirements to cable basket.
   4. Refer to drawings for installation heights and clearances between cable basket and building structures.

E. Ladder and Wire Basket Cable Trays
   1. Install cable tray systems in accordance with manufacturer’s instructions and recognized industry practices and ensure that the installed system complies with requirements of the NEC and applicable portions of NFPA 70B, NEMA VE-2 “Cable Tray Installation Guidelines” and NECA’s “Standards of Installation” pertaining to general electrical installation practices. Install cable basket system using splice connectors, support components, and other accessories by the same manufacturer.
   2. Splice system sections using UL classified connector bolt, supplied by the same manufacturer. Splicing assemblies shall be the bolted type using serrated flange locknuts.
   3. Bends shall have a minimum of a 12” bend radius.
   4. Provide radius shields at each bend/corner of “T” type intersections and cross intersections.
   5. Provide blind ends where cable tray termination is exposed (i.e. not at a wall)
   6. Ground system per NEC 70 Article 250. Provide approved connection bolt to join system sections such that the spine of the system is considered a bonding jumper. Properly bond system to approved ground, as per NEC Article 250. Provide external grounding strap at expansion joints, sleeves, crossovers, and at other locations where system continuity is interrupted.
   7. Test support systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with specified maximum grounding resistance. See NFPA 70B, Chapter 18, for testing and test methods.
   8. Provided Cable Dropout in all locations where the cable transitions out of the tray more than 6”. This includes transitions from all cable trays to equipment racks or other pathways.

F. Cable Hangers and Flat Bars
1. Install hangers in accordance with recognized industry practices, to ensure that the installed system complies with requirements of the NEC, and applicable portions of NFPA 70B and NECA’s “Standards of Installation” pertaining to general electrical installation practices.

2. Provide dedicated supports at stud locations with a maximum of forty-eight (48") separation.

3. Suspend wire or rod using components appropriate for the structure – e.g., powder-actuated clip fastener for wire, beam flange clip or angled flange clip for either wire or rod, or an embedded anchor for the threaded rod. Do not share support (wire/rod) with other trades. Do not support the hanger on ceiling grid supports. Do not support the hanger from ductwork, piping, or other equipment hangers.

4. Install hangers six inches (6"), minimum, from light fixtures or other EMI source. Install hangers between six inches (6") and twelve inches (12") above ceiling grid.

G. Conduit

1. Locations of conduit runs shall be planned in advance of the installation and coordinated with ductwork, plumbing, ceiling and wall construction in the same areas and shall not unnecessarily cross other conduits or pipe, nor block access to mechanical or electrical equipment.

2. Where practical, install conduits in groups in parallel vertical or horizontal runs and at elevations that avoid unnecessary offsets.

3. All conduits shall be run parallel or at right angles to the centerlines of columns and beams.

4. Conduits shall not be placed closer than 12 inches to a flue, parallel hot water, steam line or other heat producing source or three inches from such lines when crossing perpendicular to the runs.

5. Exposed conduit installation shall not encroach into the ceiling height headroom of walkways or doorways. Where possible, install horizontal raceway runs above water and below steam piping.

6. In long runs of conduit, provide sufficient pull boxes inside buildings to facilitate pulling wires and cables, with spacing not to exceed 150 feet. Support pull boxes from structure independent of conduit supports. These pull boxes are not indicated on the Drawings.

7. Provide all reasonably inferred standard conduits fitting and products required to complete conduit installation to meet the intended application whether noted, indicated or specified in the Contract Documents or not.

8. Install conduit in accordance with Manufacturer's written instructions, as indicated on Drawings and as specified herein.

9. Minimum Conduit Size: Unless otherwise noted herein or on Drawings, minimum conduit size shall be 1-1/4".

10. Install conduits in complete runs before pulling in cables or wires.

11. Install conduit free from dented, bruises or deformations. Remove and replace any damaged conduits with new undamaged material.

12. Conduits shall be well protected and tightly covered during construction using metallic bushings and bushing "pennies" to seal open ends.
13. Clean any conduit in which moisture or any foreign matter has collected before pulling in conductors. Paint all field-threaded joints to prevent corrosion.
14. In all empty conduits or ducts, install a “True Tape” conduit measuring tape line to provide overall conduit length for determining length of cables/conductors for future use.
15. Conduit systems shall be mechanically and electrically continuous throughout.
16. Metallic conduit shall not be in contact with other dissimilar metal pipes (i.e. plumbing).
17. Make bends with standard conduit bending hand tool or machines. The use of any item not specifically designed for the bending of electrical conduit is strictly prohibited.
18. A run of conduit between terminations at wire pulling points shall not contain more than the equivalent of two quarter bends (180 degrees, total).

H. Outlet Boxes
1. Install device/outlet boxes in accordance with manufacturer's written instructions, as indicated on drawings, and as specified herein.
2. Install boxes at the locations and elevations indicated on the drawings. Adjustment as required by field conditions and as coordinated with electrical and other trades.
3. Leave no unused openings in any box. Install close-up plugs as required to seal openings.
4. Provide cast metal boxes with gasketed cast metal cover plates where boxes are exposed in damp or wet locations or located in hazardous areas.
5. Use conduit outlet bodies to facilitate pulling of conductors or to make changes in conduit direction only. Do not make splices in conduit outlet bodies.

I. Waterproofing:
1. At floor, exterior wall and roof conduit penetrations, completely seal clearances around the conduit and make watertight.
2. For roof penetrations, provide roof flashing, counter flashing and pitch-pockets.
3. Provide membrane clamps and cable sealing fittings for any conduit that horizontally penetrates the waterproof membrane.
4. Conduits entering the building within grade that horizontally penetrate a waterproof membrane shall fall away from and below the penetration on the exterior side a minimum of two times the conduit diameters.

3.04 TERMINATIONS AND JOINTS

A. Use raceway fittings that are of types compatible with the associated raceway and suitable for the use and location.
B. Raceways shall be joined using specified couplings or transition couplings where dissimilar raceway systems are joined.

C. Conduits shall be securely fastened to cabinets, boxes and gutters using two locknuts and an insulating bushing or specified insulated connectors. Where joints cannot be made tight, use bonding jumpers to provide electrical continuity of the raceway system. Where terminations are subject to vibration, use bonding bushings or wedges to assure electrical continuity. Where subject to vibration or dampness, use insulating bushings to protect conductors.

D. Conduit terminations exposed at weatherproof enclosures and cast outlet boxes shall be made watertight using specified connectors and hubs.

E. Raceway seal: Inject into wire filled raceways, a pre-formulated rigid 2 lbs. density polyurethane foam which expands a minimum 35 times its original bulk. Foam shall have the physical properties of water vapor transmission of 1.2 to 3.0 perms; water absorption less than 2% by volume, fungus and bacterial resistant. Foam shall permanent seal against water, moisture, insects and rodents. Install raceway sealing foam at the following points:
   1. Where conduits pass from warm locations to cold locations to prevent passage of water vapor (such as refrigerated spaces, constant temperature rooms, air-conditioned spaces, etc.).

3.05 SUPPORTS

A. Secure raceways and systems to building structures using approved fasteners, clamps and hangers spaced according to the NEC and as specified in structural drawings for the project.

3.06 FINAL INSPECTION AND CERTIFICATION

A. Punch the Work of this Section compliant to the requirements of Section 27 00 00.

B. Comply with system acceptance and certification requirements of Section 27 00 00.

C. FWISD Network Infrastructure will not approve or accept any pathway installation that does not meet the installation requirements and codes listed in this document.

END OF SECTION 27 05 28
SECTION 27 08 00 - COMMUNICATIONS SYSTEM COMMISSIONING

PART 1 – GENERAL

1.01 WORK INCLUDED

A. Systems and equipment Start-Up and Functional Performance Testing.

B. Validation of proper and thorough installation of Division 27 systems and equipment.

C. Generic Start-Up Documentation for Communications systems and equipment.

D. Development of final Start-Up Documentation for electrical systems and equipment.

E. System Start-Up and Turn-Over procedures.

F. Coordination and execution of Training Events.

1.02 GENERAL DESCRIPTION

A. This section defines responsibilities of the Communication Contractor to commission the Communication Systems.

B. Commissioning is a process to demonstrate that each system has been provided by the CM in strict accordance with the Contract Documents and that building systems perform interactively and reliably according to the design intent and the Owners operational needs, in a systematic process.

C. Commissioning Authority (CA) shall work with the Contractor and the design engineers to direct and oversee the Cx process and perform Cx Testing.

D. The Commissioning Plan outlines the Commissioning process and is part of the Construction Contract.

E. Commissioning shall be performed in accordance with the Contract Document requirements and related commissioning specification sections. All recommendations and suggested practices contained in these Commissioning Standards shall be considered mandatory with the most stringent between the Contract Documents or Standards being required. The Commissioning Standard shall be used as a reference for all aspects of Commissioning, and calibration of Commissioning instruments. Quality requirements provisions of the Commissioning Standard such as performance guarantees shall be part of this contract. For systems or system components
not covered in these Commissioning Standards, Commissioning procedures shall be developed in
the Related Sections. Where new procedures, requirements, etc., applicable to the Contract
requirements set forth, the requirements and recommendations contained in these procedures
shall be considered mandatory.

1.03 SCOPE

A. The following systems and equipment are included in the Scope of Commissioning for this
project: Entirety of division 27 and 28 devices and systems.

B. Communication Systems: The following Division 27 equipment and systems are subject to
commissioning. All components and devices that make up these systems are included.

1.04 RELATED WORK AND DOCUMENTS

A. The Cx process references many related Sections, particularly Section 01 91 00 - General
Commissioning. It is important for all Contractors subject to the Cx process to be familiar with
the contract documents and industry standards.

B. Refer to Section 01 91 00 for a complete list of Sections on Related Work.

C. Drawings and general provisions of Contract, including General and Supplementary Conditions
and Division-1 Specification sections, apply to work of this section.

1.05 DEFINITIONS AND ABBREVIATIONS

A. Refer to Section 01 91 00 for a complete list of Definitions and Abbreviations.

1.06 REFERENCE STANDARDS

A. National Electric Code (NEC)

B. American Society for Testing and Materials (ASTM)

C. Electronics Industry Association/Telecommunications Industry Association (EIA/TIA)

D. Institute of Electrical and Electronics Engineers (IEEE)

E. International Electrical Testing Association (NETA)
F. National Electrical Manufacturers Associates (NEMA)

G. National Fire Protection Association (NFPA)

H. Underwriters Laboratory, Inc. (UL)

I. Refer to Section 01 91 00 for additional Reference Standards.

1.07 DOCUMENTATION

A. Documentation shall be as required in Section 01 91 00. In addition, Contractor shall also provide to the CA the following per the procedures specified herein, in the Cx Plan, and in other Sections of the specification:
   1. Factory Test Reports: Contractor shall provide any factory testing documentation or certified test reports required by the specifications. These shall be provided prior to Acceptance Phase. Factory Test Reports shall be provided in PDF electronic format.
   2. Field Testing Agency Reports: Provide all documentation of work of independent testing agencies required by the specification. These shall be provided prior to Acceptance Phase. Field Testing Agency Reports should be provided in PDF electronic format.

1.08 SEQUENCING AND SCHEDULING

A. Refer to Section 01 91 00.

1.09 COORDINATION MANAGEMENT PROTOCOLS

A. Coordination responsibilities and management protocols relative to Cx are initially defined in other sections and the Cx Plan, but shall be refined and documented in the Construction Phase Cx Kick-Off Meeting. Contractor shall have input into the protocols to be used and all Parties will commit to scheduling obligations. The CA will record and distribute.

1.10 CONTRACTOR RESPONSIBILITIES

A. Detailed Contractor responsibilities common to all Divisions are specified in other sections. The following are additional responsibilities or notable responsibilities specific to Division 27.

B. Construction Phase

C. Acceptance Phase
   1. Perform functional performance testing in presence of CA. Performance will generally include the following:
2. Manipulate systems and equipment to facilitate testing while observed by the CA as dictated in Section 01 91 00. In some cases this will entail a 20% sampling. (It is noted that no sampling by subcontractors is permitted in prefunctional checklist execution.)

3. Provide any specialized instrumentation necessary for functional performance testing.

4. Subcontractor to furnish a set of red-lined drawings to the CA prior to the start of Functional Performance Testing.

5. By direction of CA during Functional Performance Testing, contractor is to test all operating modes, interlocks, control responses and responses to abnormal or emergency conditions and verify proper response of system.

6. Contractor provide technicians, instrumentation, specialized tools, and equipment to test functional performance.

7. Note that contractor is obligated to pretest equipment/systems using the published Functional Performance Test in advance of the Functional Performance Test witnessed by the CA.

8. The acceptance phase ends with the successful completion of all Functional Performance Testing and sign off by CA.

1.11 EQUIPMENT SUPPLIER RESPONSIBILITIES

A. Refer to Section 01 91 00.

1.12 CONTRACTOR NOTIFICATION AND SCHEDULING

A. Refer to Section 01 91 00.

1.13 START-UP DOCUMENTATION

A. Refer to Section 01 91 00.

1.14 EQUIPMENT NAMEPLATE DATA

A. Refer to Section 01 91 00.

1.15 FUNCTIONAL PERFORMANCE TESTING

A. Participating Parties

B. Communication System Contractor, and Construction Manager shall all participate in the all Functional Performance Testing.

C. Documentation, non-conformance, and approval of tests

1. The CA shall witness and document the results of all Functional Performance Tests, Integrated System Test and Entire Facility Integration Tests.

2. Non-Conformance
a) The CA will record the results on the test form. All non-conformance issues shall be noted on an issues log.
b) Corrections to non-conformance issues identified may be made during the tests at the discretion of the CA. In such cases, the issue and resolution will be documented on the procedure form.
c) After the day’s work, the CA sends the non-compliance reports as issues. The sub corrects the issue and responds with their corrective actions to the issue certifying the equipment is ready to be retested.
d) The cost for the CA to witness a retest shall be the responsible subcontractor’s. The Owner will back charge the CM and pay the CA for the retesting.
e) The additional time for the CA to direct any retesting required because a specific component or system checklist or start-up test item, reported to have been successfully completed, but determined during testing to be faulty will be backcharged to the CM by the Owner.

1.16 FPT ACCEPTANCE CRITERIA

A. Acceptance criteria for tests are indicated in the specification Sections applicable to the systems being tested. Unless indicated otherwise, the criteria for acceptance will be that specified with the individual system, equipment, component, or device, which shall typically conform to applicable the referenced technical specifications.

1.17 TRAINING

A. Contractors, subcontractor, vendors, and other applicable Parties shall prepare and conduct training sessions on the installed systems and equipment they are responsible for and the individual Specifications.

1.18 SYSTEMS MANUAL AND O&M DOCUMENTATION CONTENT - PREPARATION AND LOGISTICS

A. Refer to Section 01 91 00 of the individual Specifications.

PART 2 – PRODUCTS

2.01 INSTRUMENTATION

A. General: All testing equipment used by any Party shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified. Unless otherwise noted, all equipment shall be calibrated according to the manufacturer’s recommended intervals. Calibration tags shall be affixed or certificates readily available.
PART 3 – EXECUTION

3.01 GENERIC START-UP DOCUMENTATION - GENERAL

A. Part III of this Section outlines ‘generic’ or minimally acceptable Start-Up Documentation (which are defined to include both ‘Start-Up Checks’ and ‘Start-Up Tests’) and individual systems training requirements for systems and equipment. These procedures are the direct responsibility of the Contractor as a basic element of validating that the installation is correct per normal quality control practices. These items shall provide a minimally acceptable guideline for required Contractor development of Start-Up Documentation. Contractor shall synthesize these minimum requirements along with their own internal quality control practices, those of the manufacturer, and any applicable codes and standards to develop specific and itemized final Start-Up Documentation specific to the equipment and systems installed on this project.

3.02 START-UP CHECKS COMMON TO ALL SYSTEMS

A. The following Start-Up verifications and procedures shall be considered common to all systems:
   1. Checkout shall proceed from lower level devices to larger components to the entire system operation.
   2. Verify labeling is affixed per specification and visible.
   3. Verify prerequisite procedures are done.
   4. Inspect for damage and ensure none is present.
   5. Verify system is installed per the manufacturer’s recommendations.
   6. Verify system has undergone Start-Up per the manufacturer’s recommendations.
   7. Verify that access is provided for inspection, operation and repair.
   8. Verify that access is provided for eventual replacement of the equipment.
   9. Verify that record drawings, submittal data and O&M documentation accurately reflect the installed systems.
  10. Verify all recorded nameplate data is accurate.
  11. Verify that the installation ensures safe operation and maintenance.
  12. Verify specified replacement material/attic stock has been provided as required by the Contract Documents.
  13. Verify all monitoring and ensure all alarms are active and set per Owner’s requirements.
  14. Complete all nameplate data and confirm that ratings conform to the design documents.

END OF SECTION 27 08 00
SECTION 27 08 11 - COMMUNICATIONS TWISTED PAIR TESTING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Testing of Communications Twisted Pair Cabling for both Backbone and Horizontal Cabling subsystems.

B. Related Sections
   1. Comply with the Related Sections paragraph of Section 27 00 00.
   2. Section 27 13 13 - Communication Twisted Pair Cabling

1.02 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

1.03 DEFINITIONS

A. Refer to Definitions of Section 27 00 00, Section 27 13 13

B. In addition to those Definitions of Section 27 00 00, the following list of terms as used in this specification defined as follows:
   1. “CAT6A”: Shall mean Augmented Category 6 cabling, per ANSI/TIA-568-C.2
   2. “CAT5E”: Shall mean Enhanced Category 5 cabling, per ANSI/TIA-568-C.2
   3. “Channel”: Shall mean a testing configuration which includes the Permanent Link and the line cord (at the workstation), the equipment cord, and, if a full crossconnection is implemented, a patch cord and the crossconnect termination/connecting apparatus.
   4. “Connect”: Shall mean install all required patch cords, equipment cords, crossconnect wire, etc. to complete an electrical or optical circuit.
   5. “Cord”: Shall mean a length of cordage having connectors at each end. The term “Cord” is synonymous with the term “Jumper” and “Lead”.
   6. “Permanent Link”: Shall mean the ‘permanent’ portion of the Horizontal cabling to each outlet with the test cords de-embedded from the measurements; this includes cable, consolidation point (if used), termination/connecting apparatus in the IDF and the connector at the outlet.
   7. “System Cord”: Shall mean the cord used in the operating transmission circuit.
   8. “Test Cord”: Shall mean the cord certified for use in testing, as described in this section.

1.04 SYSTEM DESCRIPTION

A. Refer to Section 27 00 00, and Section 27 13 13 for addition system description information.
B. Work Provided Under Other Sections
   1. Backbone twisted pair cabling
   2. Horizontal twisted pair cabling

C. Base Bid Work
   1. Testing of a completed communication infrastructure cabling system, which includes:
      a. Submittals
      b. Testing of the twisted pair cabling as follows:

<table>
<thead>
<tr>
<th>Subsystem</th>
<th>Type</th>
<th>Test</th>
<th>Configuration</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Backbone</td>
<td>OSP</td>
<td>*see “Notes”</td>
<td>-</td>
<td>Wire map &amp; length</td>
</tr>
<tr>
<td>Backbone</td>
<td>ISP/Riser</td>
<td>*see “Notes”</td>
<td>-</td>
<td>Wire map &amp; length</td>
</tr>
<tr>
<td>Horizontal</td>
<td>CAT6A</td>
<td>Category 6A</td>
<td>Permanent Link</td>
<td>Per EIA-568-C.2, 6.3</td>
</tr>
<tr>
<td>Horizontal</td>
<td>CAT5E</td>
<td>Category 5e</td>
<td>Permanent Link</td>
<td>Per EIA-568-C.2, 6.3</td>
</tr>
</tbody>
</table>

   c. Record Documents, including test results.

1.05 SUBMITTALS

A. Comply with the Submittal requirements of Section 27 00 00.

B. Submittal Requirements at Start Of Construction:
   2. Product Submittal, including cut sheets of testing equipment to be used (note all software/ firmware versions as applicable).
   3. Schedule Submittal, consisting of proposed schedule of work. This schedule may be combined with the schedule developed for Division 27.

C. Submittal Requirements at Closeout:
   1. Record Documents:
      a. Submit one hard copy of warranty certificate.
      b. Format – Soft Copy:
         a. “Burn” onto one CD-ROM test report files as native data format (for example, an *.FLW file from a Fluke tester); if not possible to submit in native format, then issue test results as an exported Microsoft Excel compatible format.
         b. Include onto CD-ROM ‘Viewer’ software necessary to view, sort, filter, and print individual and summary test results from test results native format.
      c. Clearly label the CD-ROM with the following information:
         1) Client Name
2) Project Name and Address
3) CD-ROM Name (e.g., “Test Reports for Horizontal Cabling System”)
4) Date of Submittal – date format: <month> <day>, <year> (e.g., “January 1, 2020”)
5) Contractor Name
d. Include a Table Of Contents at the beginning that lists the contents
e. Organize the test reports by Backbone Cabling / Horizontal Cabling, by building, by floor, and by IDF.
f. Sort reports in ascending cable ID order
g. Include tabbed separators for improved navigation through the manual

1.06 QUALITY ASSURANCE

A. Comply with the Quality Assurance requirements of Section 27 00 00.

B. Under no circumstances shall any cable’s and/or conductor’s test results be substituted for another’s. If an instance of falsification is confirmed, the Contractor is liable for a complete retest of the cabling system at no additional cost to the Owner. This includes the retaining the services of a neutral party to observe all retesting.

1.07 WARRANTY

A. Warrant the validity of the test results.

PART 2 - PRODUCTS

2.01 BACKBONE TWISTED PAIR CABLING TESTER

A. Areas of Test Measurement (minimum): Wire Map (continuity, opens, shorts, crossed pairs, split pairs): Siemon test unit, with 25-pair adapter, or equal.

2.02 CATEGORY 6A HORIZONTAL CABLE TESTER

A. Equipment shall meet TIA/EIA-568-C.2-10 testing requirements. Equipment shall meet TIA/EIA-568B.2 Addendum 1 requirements for Level III accuracy. Equipment shall meet ISO/IEC Class C, D, E, and F.

B. Test Standards (minimum): TIA Category 6A (per TIA/EIA-568C.2 Addendum 1); ISO/IEC 11801 Class C and D; ISO/IEC 11801-2000 Class C and D, 1000Base-T, 100Base-TX; IEEE 802.3 10Base-T; ANSI TP-PMD; IEEE 802.5

C. Areas of Test Measurement (minimum): Wire Map; Length; Insertion Loss; Near End Crosstalk (NEXT) loss, at both master unit and remote unit; Power Sum NEXT (PSNEXT) loss, at both master unit and remote unit; Return Loss (RL), at both master unit and remote unit; Propagation Delay and Delay Skew; Attenuation-to-Crosstalk Ratio (ACR), at both master unit and remote unit; Power Sum ACR
(PSACR), at both master unit and remote unit; Characteristic Impedance; DC Loop Resistance; and calculations for Power Sum ANEXT (PSANEXT) and Power Sum AFEXT (PSANEXT) loss, and for Power Sum Alien Attenuation-To-Crosstalk Ratio Far-End (PSAACRF) loss

D. Equipment: Fluke Networks
1. Versiv series test kit (main unit, remote unit, CAT6A permanent link adapters, CAT6A channel adapters, accessories), loaded with the latest firmware version.

PART 3 - EXECUTION

3.01 SCHEDULING

A. Prepare a construction schedule based on the schedule developed in Section 271313 and Section. Prepare updated schedules when changes in the schedule occur.

3.02 FIELD QUALITY CONTROL

A. Calibrate test sets and associated equipment per the manufacturers printed instructions at the beginning of each day’s testing and after each battery charge. Fully charge the test sets prior to each day's testing to ensure proper operation.

B. Ensure test equipment and test cords are clean and undamaged during testing activities. Per the Engineer’s discretion, halt testing activity and clean testing equipment, test cords, and related apparatus.

C. Permanently record test results.

3.03 BACKBONE TWISTED PAIR CABLING TESTING REQUIREMENTS AND PROCEDURES

A. Precautions
1. Adhere to the equipment manufacturer’s instructions during all testing.
2. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
3. Fully charge power sources before each day’s testing activity

B. Testing Requirements
1. Test backbone multipair cabling per “Base Bid Requirements” in Part 1 of this Section.
2. The installation will be accepted when testing has indicated availability of 100% terminated pairs.

C. Testing Procedures
1. Test continuity and wire map for all pairs.
2. Test length for 2% of pairs of each cable. Pairs shall be from different 25-pair binder groups.

D. Record Documents:
1. Cable and pair identifiers of the test reports shall match the identifiers as labeled in the field – i.e., use the same ID on the cable label/termination label as what appears on the test reports.
2. Measurements shall carry a precision through no significant decimal place.
3. Each test report shall contain the following information (not necessarily in this order):
   a. Project name
   b. Cable identifier, pair number(s)
   c. Date measurement were obtained
   d. Operator (company and name)
   e. Test equipment model and serial number(s)
   f. Measurement results

3.04 HORIZONTAL CATEGORY 6A TESTING PROCEDURES

A. Precautions
1. Adhere to the equipment manufacturer’s instructions during all testing.
2. Prior to any testing activity or any measurements taken, ensure the test equipment is at room temperature – approximately 70 degrees F (e.g., if necessary, bring the test equipment in from outdoors and let it set for about 15 minutes or for however long it takes to bring the test equipment to reach room temp).
3. Fully charge power sources before each day’s testing activity

B. Test Equipment Set Up
1. Set up the tester to perform a full CAT6A test, as a Permanent Link configuration.
2. If the tester has the capability, set the cable type as product-specific setting. If not, set as generic CAT6A.
3. Set the tester to save the full test results (all test points, graphs, etc.).
4. Save the test results with the associated cable link identifier.
5. Calibrate the test set per the manufacturer’s instructions.

C. Acceptable Test Result Measurements
1. Overall Test Results:
   a. The Owner shall accept only individual test results that result in a Pass.
   b. Links which report a Fail, Fail* or Pass* for any of the individual tests shall result in an overall link Fail.
   c. Any reconfiguration of link components required as a result of a test Fail, must be re-tested for conformance.
   d. Remove and replace any cabling links failing to meet the criteria described in this specification, at no cost to the Owner, with cables that prove, in testing, to meet the minimum requirements.
2. Wire Map: Correctly terminate all pairs of the cabling link at both ends. Provide only continuous pairs. No exceptions.
3. Length: Ninety-four meters is the maximum acceptable electrical length measurements for any cabling link measured under a Permanent Link configuration, including test cords.
4. Insertion Loss: The acceptable insertion loss measurements for any CAT6A cabling link is that which is no greater than that listed in ANSI/EIA-568-C.2, 6.3.
5. Worst Pair-to-Pair Near End CrossTalk (NEXT) Loss: The acceptable worst pair-to-pair NEXT loss for any CAT6A cable is that which is no greater than that listed in ANSI/EIA-568-C.2, 6.3.
6. Power Sum NEXT Loss: The acceptable power sum PS-NEXT loss for any CAT6A cable is that which is no greater than that listed in ANSI/EIA-568-C.2, 6.3.
7. Worst Pair-to-Pair ELFEXT and FEXT Loss: The acceptable worst pair-to-pair ELFEXT and loss for any CAT6A cable is that which is no greater than that listed in ANSI/EIA-568-C.2, 6.3.
8. Return Loss: The acceptable return loss measurements for any CAT6A cable is that which is no greater than that listed in ANSI/EIA-568-C.2, 6.3.
9. Propagation Delay and Delay Skew: The acceptable propagation delay and delay skew measurements for any CAT6A cable is that which is no greater than that listed in ANSI/EIA-568-C.2, 6.3.

D. Records
1. Permanently record test results.
2. Export all of the numerical test results to a single spreadsheet in Microsoft Excel® (*.xls) or (*.xlsx) file format.
3. Submit test results at the conclusion of the testing to the Engineer for approval. Engineer will check these test reports for a format acceptable to the Owner, or Owner’s Representative.
4. For each Horizontal CAT6A test, record the following information:
a. Project name and address
b. Testing Company’s and Operator’s name
c. Date of measurement
d. Test equipment, including the following:
   1) Manufacturer, model, and serial number
   2) Date and time of last calibration
e. Identification number of cable
f. Overall test result

END OF SECTION 27 08 11
PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Buildout of communications equipment rooms.

B. Related Divisions and Sections
   1. Comply with the Related Sections paragraph of Section 27 00 00.
   2. Drawings, general provisions of the Agreement, and Division 01 apply to this Section.
   3. Consult other Divisions, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
   4. Comply with cable tray installation in Section 27 05 28

C. Unit Pricing:
   1. Unit prices shall include material, labor, shipping, tax, markups (overhead, profit, job expenses, bonding), labeling, records, and as-built drawings.

1.02 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

B. In addition to those codes, standards, etc., list in Section 27 00 00, comply with the latest edition of the following applicable specifications and standards except as otherwise shown or specified:
   1. ANSI/EIA-310-D-1992, “Racks, Panels And Associated Equipment”

1.03 DEFINITIONS

A. Definitions as described in Section 27 00 00 shall apply to this section.

1.04 SYSTEM DESCRIPTION

A. General: Communications rooms shall fall into one of the following space titles:
   1. Entrance Facility/EF
   2. Telecommunications Room/TR

B. Room Functions:
   1. Entrance Facility (EF) will serve the following functions:
      a. Act as minimum point of entry (MPOE) for telecommunications utility (e.g., AT&T)
b. House telecom utility’s termination field(s) and interface between telecom utility’s facilities and premises facilities
c. Main entrance point for all communications conduit entering the building
d. Houses network equipment (i.e. core switch/router, processing eqmt/servers) and voice system equipment (i.e. VoIP system)
e. House interbuilding and intrabuilding twisted pair and fiber optic backbone cabling and main crossconnect field
f. Houses network equipment (i.e. access switches) serving the horizontal cabling
g. Houses horizontal termination field – for voice/data/CATV – outlets served from this room (refer to floor plans for area served)
h. House voice backbone crossconnect field and data backbone crossconnect field
i. House horizontal termination field – both voice and data – of outlets served from this room (refer to drawings for area served).
j. House network equipment (i.e. access switch) serving users of the room’s service area

C. Work Covered Under Other Sections
   1. Plywood backboards
   2. Bonding
   3. Grounding busbars
   4. Power and cooling
   5. Conduit, device boxes, and sleeves

D. Base Bid Work
   1. The Work under this section includes materials, accessories, fasteners, etc., and the labor and associated services required for the buildout / fit-up of telecommunications equipment rooms, and includes coordination through the General Contractor with other trades
   2. In general, the Work includes the following:
      a. Submittals
      b. Rack bays (equipment racks, vertical management sections, anchoring)
      c. Cable, wire and patch cord management
      d. Racks and Cabinets
      e. Identification tags and labeling
      f. Record Documents
      g. Warranty

E. Coordination Requirements
   1. Electrical: Coordinate layout with electrical contractor to ensure proper placement of lighting, sequencing of power service to rack bay, and other issues related to electrical trade.
   2. Owner: Coordinate room-ready requirements and schedule with Owner (to allow Owner to plan and execute installation of telecommunications/network equipment).

1.05 SUBMITTALS

A. Comply with the Submittal requirements of Section 27 00 00.
B. Quantity: Furnish quantities of each submittal as noted in Section 27 00 00.

C. Submittal Requirements at Start of Construction:
   1. Product Data Submittal
   2. Shop Drawings Submittal: Consisting of any proposed changes to room plans.
   3. Sample Submittal: Submit sample of equipment rack label.
   4. Schedule Submittal: Submit proposed schedule of work (this schedule may be combined with the schedule developed for Division 27).

D. Submittal Requirements at Close Out:
   1. As-Built Drawings Submittal

E. Substitutions
   1. Requests for substitutions shall conform to the general requirements and procedure outlined in Section 27 00 00.

1.06 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 270000.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with Delivery, Storage and Handling requirements of Section 270000.

1.08 WARRANTY

A. Warrant Work to perform as described within this Section for a period of 1 year. Correct deficiencies within 24 hours of notification.

PART 2 - PRODUCTS

2.01 WALL EQUIPMENT RACK

A. Application: Suitable for the support of termination apparatus, cable and cord management apparatus, network equipment, and other similar equipment, within a telecommunications room.

B. Include all accessories and hardware necessary for proper installation.

C. Equipment racks shall be clearly labeled with unique 2-digit serial number reset to 01 for each TR.

D. Material: Steel sheet cabinet body, rear panel and door. Door is extruded metal frame with solid metal or tinted tempered glass panel. Equipment mounting rails are aluminum.

E. Options: Cabinet must be lockable and include tamper proof screws. Exhaust fans to be
included.

F. Wall Mount Racks:
   1. Manufacturer:
      a. CPI 12419-X36, Wall mount rack, 19 RMU, Grounded, UL Listed, Black
      b. Or equal

G. Load Rating: 300 lbs, when evenly distributed for the height of the rack

H. Finish: Black, powder coat
   1. Or equal

2.02 HORIZONTAL MANAGEMENT PANEL

   A. Application: Suitable for installation into equipment rack for horizontal cord
      management. The horizontal management panel shall match (and fully integrate with)
      the vertical management sections.

   B. The horizontal management panel shall be single-sided.

   C. Size: 1U and 2U high by 19” mounting wide.

   D. Color: black (guides and cover).

   E. Manufacturer:
      1. CPI Evolution Horizontal Cable Management System
         a. horizontal management panel, single sided, 2U, black
         b. horizontal management panel, single sided, 1U, black
      2. Or equal

2.03 LABEL PLATES, FOR EQUIPMENT RACKS

   A. Label plate shall be suitable to affix onto top angle of equipment rack or onto the top
      front of a frame/cabinet.

   B. Label plate shall be ‘engrave-able’ stock melamine plastic laminate substrate.

   C. Size (minimum): 4-inch high by 6 inches long by 1/16-inch thick

   D. Color: black

   E. Lettering shall be white, engraved, 2-inch high

PART 3 - EXECUTION

3.01 GENERAL
A. Comply with the Execution requirements of Section 27 00 00.

3.02 EXAMINATION AND PREPARATION

A. Prior to installation, verify equipment rooms are suitable for the construction scope of this section. Schedule work to prevent damage caused by other trades during the course of that other construction.

B. Prepare surfaces, such as floors, for permanent installation of products, such as racks.

3.03 INSTALLATION

A. Rack/Cabinet Bays
   1. Equipment Racks and Cabinets
      a. Provide parts and accessories required to complete each rack. Completely assemble racks, according to manufacturer’s instructions.
   2. Horizontal Management Panels
      a. Provide horizontal management panels. If not shown, provide one management panel above each patch panel and one below the bottom patch panel in each rack bay where patch panels occur.
      b. Provide fasteners and parts required to complete the installation.
   3. Accessories
      a. Furnish rack mounting screws – Turn over 1 bag of screws per Telecom Room, to the owner at the end of the project.

B. Overhead Cable Support
   1. Provide support devices (e.g., brackets and threaded rod with strut) for overhead cable management system; install per the manufacturer’s instructions and fastened to the wall or ceiling using appropriate fasteners.
   2. Provide parts required for complete installation (e.g., mounting brackets, splice kits, hardware, etc.).
   3. Tolerances
      a. Install overhead cable support centered over the equipment rack, or as shown on the Drawings.
   4. Interface with Other Work: Coordinate the installation of the overhead cable support with other trades. Trapeze supports and ‘hanger rods’ (“all-thread”), for example, may be shared to lower overall construction cost.
   5. Provide cable retaining post every 18” along cable runway pathways.
   6. Provide cable drop outs at any point cables transition to or from the cable pathway.

C. Vertical Cable Support
   1. Provide cable runway installed vertically for use to support cables routing vertically within telecommunications rooms.
   2. Provide parts required for complete installation (e.g., vertical mounting brackets, bolts, etc.).
3. Install the cable runway such that the rungs are facing outward (the greater distance from the rung to the stringer edge is facing inward)

D. Blanking Panels
   1. Provide blanking panels in all unused spaces in Network and Server cabinets.
   2. Coordinate with the owner before blanking panel installation.

3.04 LABELING
A. General Requirements: Labeling and identifier assignment shall conform to TIA/EIA-606-A Administration Standard and as approved by Owner before installation.
B. Equipment Rack Label Requirements: Provide one label plate per rack and cabinet/frame. Permanently affix label plate and position as shown on the Drawings; if not shown on the Drawings, center the label plate on the rack’s front top angle or the cabinet’s top front frame.
C. Identifier Assignment
   1. Equipment Racks
      a. Prefix: “RACK”
      b. First field: the rack letter; for example: “A”
      c. Example; “RACK A”

3.05 FINAL INSPECTION AND CERTIFICATION
A. Punch the Work of this Section compliant to the requirements of Section 27 00 00.
B. Comply with system acceptance and certification requirements of Section 27 00 00.

END OF SECTION 27 11 00
SECTION 27 13 13 - COMMUNICATIONS TWISTED PAIR CABLING

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes: Backbone and horizontal twisted pair cabling

B. CAT6 cabling will be accepted for general purpose outlets. All Wireless access points to include CAT6A cables. MiniCom components to be utilized where possible. Contractor to bid alternate with CAT5e products throughout matching brand.

C. Related Sections
   1. Comply with the Related Sections requirements of Section 27 00 00
   2. 27 08 11 Communication Twisted Pair Testing

1.02 REFERENCES

A. Comply with the References requirements of Section 27 00 00.

1.03 DEFINITIONS

A. Refer to Section 27 00 00 for Definitions.

B. In addition, define the following list of terms as used in this specification as follows:
   1. “ALVYN”: sheath type consisting of corrugated polymer-coated aluminum shield with and adhered flame retardant jacket
   2. “ARMM”: Bell system cable type (shielded riser)
   3. “CAT3”: Category 3 [UTP] performance grade
   5. “CAT6”: Category 6 [UTP] performance grade
   7. “Channel”: End to end transmission path; e.g., the entire portion of the horizontal cabling to each outlet consisting of the Permanent Link, line cord (at the workstation), patch cord, and, if a full crossconnection is implemented, the crossconnect termination/connecting apparatus and equipment cord.
   8. “CMP”: Communications Media Plenum [NEC plenum rating]
   9. “CMR”: Communications Media Riser [NEC riser {non-plenum} rating]
   10. “FEP”: Fluorinated Ethylene Propylene
   11. “FTP”: Foiled Twisted Pair
   12. “ISP”: Inside Plant Cabling
   13. “OSP”: Outside Plant Cabling
   14. “PE”: Polyethylene
   15. “Permanent Link”: Test configuration for a horizontal cabling link excluding patch cords, equipment cords, and line cords; e.g., the ‘permanent’ portion of the horizontal cabling to each outlet consisting of cable, consolidation point (if used), termination/connecting apparatus in the TRs and the connector at the outlet.
16. “PIC” Plastic Insulated Conductor
17. “PVC”: PolyVinyl Chloride
18. “PVDF”: Polyvinylidene fluoride
19. “UTP”: Unshielded Twisted Pair

1.04 SYSTEM DESCRIPTION

A. Work Covered Under Other Sections
   1. Pathways: The communications pathways (cable tray, conduits, stubs, etc.) work will be covered under another Section. Refer to the Drawings for size/capacity and route information.
   2. Rooms: Build out (e.g., backboards, overhead and vertical cable runway, etc.) of the telecommunications rooms will be covered under another Section. Refer to the Drawings for build out information.

B. Base Bid Work
   1. Provide engineering, labor, materials, apparatus, tools, equipment, and transportation required to make a complete working communications Backbone and Horizontal Twisted Pair Cabling System installation described in this Section and shown on related Drawings. Consider Backbone and Horizontal Cabling as shown on Drawings as base bid work, unless otherwise noted. This includes terminations at both ends.
   2. In general, the base bid work includes:
      a. Submittals
      b. Backbone and Horizontal cables, terminations, and outlets
      c. Cable management
      d. Patch cords and crossconnections
      e. Cable identification tags and system labeling
      f. Record Documents
      g. Warranty
   3. Coordination Instructions:
      a. Contractor terminate at patch panel and at the wall plates (data and coax).
      b. Wiring: Modular connectors shall be T568B wired.
      c. A three-foot (3’) service loop secured above ceiling prior to the end device location.
      d. Cable Colors:
         • Access Points – Yellow (YL)
         • Desktops – Grey (GY)
         • Cameras – Red (RD)
         • Key Cards, Door locks – Violet (VL)
         • Phones – Grey (GY)
         • Crossover – Green (GR)
         • AV/TV – Black (BL)
         • Lighting Controls – Green (GR)

1.05 SUBMITTALS

A. Comply with the Submittals article of Section 27 00 00 for procedural, quantity, content, and format requirements.
B. Substitutions
   1. Conform to substitutions requirements and procedure in Section 27 00 00.

C. Submittal Requirements at Start of Construction:
   1. Product Data Submittal, indicating conformance with NEC, UL, TIA/EIA listings, certifications and specifications.
   2. Sample Submittal, consisting of the following components:
      a. Type “A” Outlet Sample – one fully configured outlet including faceplate, modular jacks, and label
      b. Cable Label Sample
   3. Schedule Submittal, consisting of proposed schedule of work. This schedule may be combined with the schedule developed for 27xxxx series Sections
   4. Shop Drawings Submittal, consisting of proposed changes to cable routing, or termination locations/configurations

D. Submittal Requirements at Closeout:
   1. As-Built Drawings
   2. Cable ID—to—Office Number Key: Submit a “cable ID-to-Office number key” as an electronic file in an MS-Excel spreadsheet file format containing a list of every cable identifier associated with the final office number
   3. Crossconnection records/cut sheets
   4. O & M Manuals per section 27 00 00

E. Posted Documentation
   1. Post one full size plot of as-built drawings, specifically the floor plans and (as applicable) reflected ceiling plans, within TR’s such that show the TR’s serving area. Coordinate location with Owner.

1.06 QUALITY ASSURANCE

A. Comply with Quality Assurance requirements of Section 27 00 00.

B. Contractor Qualifications
   1. In addition to the Contractor Qualifications requirements of Section 27 00 00, the Contractor shall be certified by the manufacturer to provide the cabling system (proposed, submitted, and approved) and to provide an extended warranty. Submit satisfactory evidence of certification in the form of a current letter or certificate from the manufacturer as part of the bid.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with the Delivery, Storage and Handling requirements of Section 270000.

1.08 WARRANTY

A. The horizontal cabling system, as specified in this section, shall carry a 15-year (minimum) extended system warranty. This extended warranty shall cover parts and labor for the duration of the extended warranty. This extended warranty shall also cover electrical performance of cabling
system to the specific category per ANSI/TIA/EIA-568-C performance criteria for horizontal cabling.

PART 2 - PRODUCTS

2.01 MANUFACTURERS
   1. Panduit cabling system
   2. CommScope SYSTIMAX
   3. Belden cabling system
   4. Berktek/Ortronics cabling system

2.02 SUBSTITUTIONS

   A. Comply with the Substitutions requirements of Section 270000.

2.03 HORIZONTAL CABLE – CAT6 Minimum Compliant, CAT6 and CAT6A UTP, PLENUM (CMP) RATED (FOR USE IN RETURN AIR PLENUMS)

   A. Application: Suitable for indoor installation, within ceiling space in primary and secondary pathways, within access/raised floor space.

   B. Conductors:
      1. Insulated Conductors: 23 AWG solid copper, fully insulated with a flame retardant thermoplastic material (material = FEP, or equivalent).

   C. Cable Sheath:
      1. Outer Jacket: seamless outer jacket (material = LS-PVC, or similar) applied to and completely cover the internal components (twisted pairs).
      2. Flame Rating: NEC (Article 800) rated as CMP, and UL listed as such.

   D. Electrical Performance: Meet or exceed TIA/EIA-568-C.2, ISO 11801 Class E Edition 2.1, and IEEE Std. 802.3an channel requirements for supporting 10GBASE-T.

   E. Color: See color table in Part 3 for cable colors
      a. Manufacturer:
         1) Panduit
            a) #PUP6C04BU-U; CAT6 4 pair UTP minimum compliant cable (Net-Key WAO)
            b) #PUP6004BU-W; CAT6 4 pair UTP cable (WAO)
            c) #PUP6AV04BU-G; CAT6A 4 pair UTP cable “10Gig” (WAP)

2.04 HORIZONTAL CABLE – CAT6 Minimum Compliant, CAT6 and CAT6A UTP, RISER (CMR) RATED (TO BE USED WHERE CODE ALLOWS)
A. Application: Suitable for indoor installation, below ceiling space in cable tray between server room cabinets.

B. Conductors:
   1. Insulated Conductors: 23 AWG solid copper, fully insulated with a flame retardant thermoplastic material (material = HDP, or equivalent).

C. Cable Sheath:
   1. Outer Jacket: seamless outer jacket (material = PVC, or similar) applied to and completely cover the internal components (twisted pairs).
   2. Flame Rating: NEC (Article 800) rated as CMR, and UL listed as such.

D. Electrical Performance: Meet or exceed TIA/EIA-568-C.2, ISO 11801 Class E Edition 2.1, and IEEE Std. 802.3an channel requirements for supporting 10GBASE-T.

E. Color: See color table in Part 3 for cable colors

F. Manufacturer:
   1) Panduit
      a) #PUR6C04IG-U; CAT6 4 pair UTP minimum compliant cable (Net-Key WAO)
      b) #PUR6004IG-W; CAT6 4 pair UTP cable (WAO)
      c) #PUR6AV04IG; CAT6A 4 pair UTP cable “10Gig”, Blue

2.05 MODULAR PATCH CORDS – CAT6 and CAT6A 10 GIG RATED

A. Application: Suitable for indoor installation within a telecommunications room or workstation environment.

B. Cords assembled from a single, continuous length of cordage, homogenous in nature, and terminated at both ends via 8 position modular plugs. Splices are not permitted anywhere.

C. Cordage
   1. Insulated Conductors: 24AWG solid copper, fully insulated with a flame retardant thermoplastic material (such as PVC, or equivalent).
   2. Twisted Pairs: Two insulated conductors “twisted” into a “pair” (twisted pair), and individually color coded.
   3. Unshielded sheath and flame-retardant polyvinyl chloride (PVC) jacketed.
   4. Flame Rating: NEC CM (or higher) rated, and UL listed as such.

D. Electrical Performance: Meet or exceed TIA/EIA-568-C.2, ISO 11801 Class E Edition 2.1, and IEEE Std. 802.3an channel requirements for supporting 10GBASE-T.

E. Length: Refer to Outlet Schedule for length requirements.

F. Color:
   1. Access Points – Yellow (YL)
2. Desktops – Blue
3. Cameras – Red (RD)
4. Key Cards, Door locks – Violet (VL)
5. Phones – Blue
6. Crossover – Green (GR)
7. AV/TV – Black (BL)
8. Lighting Controls – Green (GR)

G. Manufacturer:
Panduit (*=Length, XX=Color)
   a) #UTPSP*xx; CAT6 UTP Patch Cords
   b) #UTP6ASD*xx; TX6A 10Gig UTP Patch Cords.

2.06 CROSSCONNECT WIRE

A. Crossconnect wire shall be suitable for installation within a telecommunication facility and fully compatible with the termination apparatus specified within this Section.

B. Crossconnect wire shall be manufactured from a single, continuous length of insulated wire, homogenous in nature. Splices are not permitted anywhere. Factory splices of insulated conductors are expressly prohibited.

C. Conductors:
   1. Insulated Conductors: 24 AWG conductors of solid copper. Fully insulated conductors with a flame retardant thermoplastic material (such as PVC, or equivalent).
   2. Twisted Pairs: Two insulated conductors “twisted” into a “pair” (twisted pair), individually color-coded.

D. Manufacturer:
   1. General Cable
      a. #7023864; crossconnect wire, 1 pair, Whi-Red / Red-Whi
      b. #7023708; crossconnect wire, 1 pair, Whi-Blu / Blu-Whi
   2. Or equal

2.07 BEP PROTECTOR – FOR DATA CIRCUITS

A. Application: Protectors suitable for installation within a telecommunication facility for the termination of the Horizontal OSP/Underground cables intended for data circuits.

B. Protector shall be UL 497 listed.

C. Solid-state protection with clamping voltage of 16VDC

D. Protector shall have a 4-pair capacity (minimum) with 110-type input and 110-type output

E. Manufacturer:
   1. CommScope SYSTIMAX
      a. #760028373; OSP protector, CAT6 rated, 2-cable capacity
      b. #760033951; OSP protector, CAT6 rated, for PoE circuits, 2-cable capacity
2. Or equal

2.08 MODULAR CONNECTOR / 8-POSITION JACK – CAT6 Net-Key, CAT6 and CAT6A 10GIG RATED

A. Application: Modular connectors shall be 8-position modular jacks and shall be compatible with the specified CAT6 and CAT6A UTP 4-pair cables both electrically and physically.

B. Mechanical Performance: Modular connectors shall meet or exceed TIA/EIA-568-C.2 5.7.

C. Electrical Performance: Modular connectors shall meet or exceed TIA/EIA-568-C.2 6.8 and ISO/IEC 11801 requirements for CAT6A UTP cabling.

D. Wiring: Modular connectors shall be T568B wired.

E. Manufacturer:
1. Panduit
   a) #CJ6X88TGWH; Mini-Com TX6A 10 Gig UTP Jack Modules CAT6A RJ45, 10 Gb/s, 8-position, 8-wire universal module” jack, white (WAP)
   b) #CJ688TGWH; Mini-Com TX6 CAT6 UTP Jack Modules (WAO)
   c) #NK688MWH; Net-Key CAT6 Jack Modules (WAO)

2.09 WORK AREA OUTLETS

A. Faceplates for Standard Flush-Mount Outlets
   1. Application: Faceplates shall be suitable for indoor installation for standard 1-gang and 2-gang flush-mount devices.
   2. Faceplates shall have 2, 3, 4, or 6 ports, and shall include required accessories, such as icons, blank inserts, label windows and labels.
   3. Color: White
   4. Manufacturer:
      a. Panduit
         1) #CFPE1WHY; Mini-Com faceplate, 1-gang, 1 port, white
         2) #NK1FWHY; Net-Key faceplate, 1-gang, 1 port, white
         3) #CFPL2WHY; Mini-Com faceplate, 1-gang, 2 port, white
         4) #NK2FWHY; Net-Key faceplate, 1-gang, 2 port, white
         5) #CFPL4WHY; Mini-Com faceplate, 1-gang, 4 port, white
         6) #NK4FWHY; Net-Key faceplate, 1-gang, 4 port, white
         7) #CFPL6WHY; Mini-Com faceplate, 1-gang, 6 port, white
         8) #NK6FWHY; Net-Key faceplate, 1-gang, 6 port, white
   B. Surface Outlets
      1. Application: Surface outlets shall be suitable for indoor installation for surface-mount device and shall be fully compatible with the specified modular connectors/jacks.
      2. Color: White
      3. Manufacturer:
         A. Panduit
            1) #CBX1WH-A; Mini-Com surface mount box, 1 port, white
            2) #CBX2WH-A; Mini-Com surface mount box, 2 port, white
3)  #NK2BXWH-A; Net-Key surface mount box, 2 port, white  
4)  #CBX4WH-AY; Mini-Com surface mount box, 4 port, white  
5)  #NK4BXWH-AY; Net-Key surface mount box, 4 port, white

B.  Or Equal

2.10  CABLE LABELS

A. Labels shall be machine printable with a laser printer, ink jet printer, thermal transfer printer, or hand-held printer.

B. Label shall fully wrap around the cable’s jacket, shall be adhesive-backed labels, and shall have a self-laminating feature.

C.  Size: 1” x 0.5” printable area, minimum

D.  Color: white

E.  Manufacturer:
   a.  Panduit
      1)  #S100X150YAJ; cable labels, 1.0” x 1.5”, for cable diameters 0.16”-0.32”, white  
      2)  #S200X225YAJ; cable labels, 2” x 2.25”, for cable diameters 0.24”-0.48”, white  
      3)  #S200X400YAJ; cable labels, 2” x 4”, for cable diameters 0.32”-0.95”, white  
   b.  Or Brady equal

F.  Owner Requirements:

1.  Cables shall be labeled at each end clearly marking the connection the cable establishes. Additional labels should be included on segments of the cable that go through manholes and hand-holes.

2.  Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.

3.  Where possible, labels shall be affixed above a jack in a patch panel. Where it is not possible to do so, pre-labeled numbered patch panels must be used and a cross-reference map must be provided showing which cables are connected to which jacks in a patch panel.

2.11  MISCELLANEOUS COMPONENTS

A.  Velcro Cable Ties

1.  Width: .75”.

2.  Color: Velcro cable ties the same color as the cable to which it is being applied.

3.  Manufacturers:
   a.  Panduit “Tak-Ty” series cable ties
b. Panduit #HLS-15R-0; black, 15’ roll, cut to length.
c. Or Equal

B. Plenum Cable Ties
1. Application: for use in plenum or air handling spaces
2. Color: maroon or other distinctive non-white color
3. Manufacturer
   a. Panduit
      1) #PLT1M-xxxx
      2) #PLT2S-xxxx
      3) #PLT3S-xxxx
   b. Or Equal.

2.12 OSP DUCT PLUGS

A. Multi-Port Duct plugs
1. Manufacturer
   a. Tyco
      1) #40B167S; 4-inch triplex plug
      2) #40Q136S; 4-inch quadplex plug
   b. Carlon
   c. Condux
   d. Or equal

B. Port/Cable plugs, for securing one cable per duct plug port.
1. Manufacturer:
   a. Tyco
      1) #10S035S; simplex plug for one fiber optic cable in 1-inch ID port
      2) #11S057SB; simplex plug for one fiber optic cable fiber in 1¼-inch ID port
      3) #10D104U; blank port plug for 1-inch ID port
      4) #12D148U; blank plug for 1¼-inch ID port
   b. Carlon
   c. Or equal

C. Blank Duct Plug for 4” Conduit
1. Manufacturer
2. a. Tyco # JM-BLA-40D402U; blank duct plug for 4” conduits
   b. Carlon
   c. Or equal

2.13 TERMINATION APPARATUS – MODULAR FACEPLATE PATCH PANELS

A. Modular patch panels shall be suitable for installation within a telecommunication room for the termination of the Horizontal Cables specified herein. Modular patch panels shall be horizontally
oriented for a rack-mounted configuration. Modular patch panels shall be capable of supporting, organizing, labeling and patching/crossconnecting between the horizontal termination field and the equipment termination field. Modular patch panels shall be supplied with an integrated strain relief bar in the rear of the panel for cable management.

B. 48-port angled patch panel with labels, supplied with twelve factory installed CFFPL4 type front removable snap-in faceplates, populated with category 6A modular inserts per section 2.22.

C. Manufacturer:
   1. Panduit
      a. 48-Port 10GX Patch Panel 48-port, 2U #CP48WSBLY

PART 3 - EXECUTION

3.01 GENERAL
   A. Comply with the Execution requirements of Section 270000.

3.02 EXAMINATION AND PREPARATION
   A. Rooms: Prior to installation, verify equipment rooms are suitable to accept the horizontal cables and terminations.
   
   B. Pathways: Prior to installation verify that pathways and supporting devices, provided under other sections, are properly installed, and that temporary supports, devices, etc., have been removed. Verify dimensions of pathways, including length (for example, “True Tape” the conduits).
   
   C. Cable Integrity: Prior to installation, verify the cable’s integrity – both sheath and conductors. Documentation of pre-installation testing is not a close out requirement, and is the responsibility of the Contractor.

3.03 INSTALLATION
   A. Backbone Cable Installation and Routing
      1. Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
      2. Placement
         a. Place cables within designated pathways.
         b. Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
         c. Maintain pulling tension within manufacturer's limits.
         d. Place and suspend cables in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables if damaged during installation
c. Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.

3. Routing
   a. When routing horizontally within telecommunications rooms, utilize the overhead cable support. When routing vertically within telecommunications rooms, utilize the vertical cable support and provide cable ties every 24 inches on center using.
   b. Route cables a minimum of 6" away from power sources to reduce interference from EMI.

   c. Termination
   d. Provide 15 feet cable slack loop at each end of the run. Store slack in overhead cable support or as noted on Drawings.
   e. Properly relieve strain from cables at termination points per manufacturer’s instructions.
   f. Terminate twisted pairs onto the termination apparatus in accordance with manufacturer’s latest instructions and TIA/EIA-568-B standard installation practices.
   g. Perform post-installation testing as described in the Telecommunication Testing specification.

B. OSP Interbuilding Backbone Cable
   1. Cable runs shall have continuous sheath continuity, homogenous in nature, between either termination points or designated splices points. Only splices as noted on the Construction Documents are permitted.

   2. Placement
      a. Place cables within designated pathways.
      b. Maintain a minimum bend radius of 6 times the cable diameter during installation.
      c. Maintain pulling tension within manufacturer’s limits. Only use UL approved cable-pulling compounds when necessary to reduce pulling tensions.
      d. Protect cable during installation. Place and suspend cables in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cable if damaged during installation.
      e. Neatly dress and organize cables in the cable routing facilities, and fastened to support devices via tie wraps.
      f. Place a pull rope along with cables where run in conduit and spare capacity still exists in the conduit. Tie off ends of the pull rope.

   3. Routing:
      a. When routing horizontally within telecommunications rooms, utilize the overhead cable support; route backbone cables to avoid crossing over horizontal cabling or horizontal cabling crossing backbone cabling. When routing vertically within telecommunications rooms, utilize the vertical cable support and provide cable ties every 24 inches on center using.
      b. Route cables a minimum of 6" away from power sources to reduce interference from EMI.

   4. Termination
      a. Provide 15 feet cable slack loop at each end of the run. Store slack in overhead cable support or as noted on Drawings.
      b. Properly strain relieve cables at designated points per manufacturer’s instructions.
c. Terminate copper pairs at both ends on the specified <BEP> <termination apparatus>. Perform terminations in accordance with manufacturer’s instructions and TIA/EIA-568-B standard installation practices.

5. Labeling
   a. Provide labels on each end of the cable, no more than 4" from where the cable enters the specified splice closure or termination apparatus.
   b. Place labels such that they are visible by a technician from a normal stance.
   c. Refer to FWISD TDG for labeling information.

C. Duct Plugs
   1. Provide blank plugs in unused ducts.
   2. Provide multi-port duct plugs at duct ends with cables.
   3. Provide cable plugs for each cable. Secure each twisted pair cable at each telecommunications vault, building entrance, and MPOE/ER with a cable plug sized depending upon the outside diameter of the cable.
   4. Provide blank port plug in each used duct port.

D. Horizontal Cable Installation and Routing
   1. Cable runs shall have continuous sheath continuity, homogenous in nature. Splices are not permitted anywhere.
   2. Place cables within designated pathways, such as cable tray, cable hangers, etc. Do not fasten (such as with cable ties) or attach cables to other building infrastructure (such as ducts, pipes, conduits, etc), other systems (such as ceiling support wires, wall studs, etc), or to the outside of conduits, cable trays, or other non-approved pathway systems.
   3. Place and suspend cables and conductors during installation and termination in a manner to protect them from physical interference or damage. Place cables with no kinks, twists, or impact damage to the sheath. Replace cables damaged during installation or termination at no additional cost.
   4. Maintain minimum cable length of 15 meters from the termination in the TR to the termination at the user’s faceplate (permanent link).
   5. No cable length shall exceed 90 meters from the termination point in the TR to the termination point at the work area (permanent link).
   6. Route cables at 90-degree angles, allowing for bending radius, along corridors for ease of access.
   7. Do not exceed manufacturer's limits for pulling tension.
   8. Do not use cable-pulling compounds for indoor installations.
   9. Maintain a minimum bend radius of 6 times the cable diameter during and after installation.
   10. Route cables under building infrastructure (such as ducts, pipes, conduits, etc); Do not route cables over building infrastructure. The installation shall result in easy accessibility to the cables in the future.
   11. Place cables 6", minimum, away from power sources to reduce interference from EMI.
   12. For 3” trade size conduits and larger, place a pull string along with cables where run in pathways and spare capacity in the pathway remains. Tie off ends of the pull string (to prevent the string from falling into the conduit).
   13. Neatly dress and organize cables using designated cable routing facilities, and fasten to support devices via tie wraps or Velcro-type straps.
14. When exiting the primary pathway (such as cable tray) to the work area, exit via the top of the pathway. Secure the cables to the pathway using an approved cable tie.

E. Cable Routing and Dressing within the TR
   1. Place cables within the overhead cable support and, when routing vertically, fasten the cables onto wall-mounted vertical cable support every 24 inches on-center using cable ties.
   2. At the rack bay, route cables into the back of the vertical management sections. Divide the cables equally between both sides of an equipment rack such that a cable does not travel past the midpoint of the rack prior to termination.
   3. Provide 10 feet, minimum, sheathed cable slack – length not to exceed permanent link maximum length requirement. Place the slack in the overhead cable support.

F. Termination in the TR/ER
   1. Provide termination apparatus and accessories required for a complete installation. Install and assemble termination apparatus, accessories and associated management apparatus according to the manufacturer’s instructions.
   2. Properly strain relieve cables to and at termination points per manufacturer’s instructions.
   3. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and ANSI/TIA-568-C.0 standard installation practices. Terminate cable pairs onto the termination apparatus. Terminate twisted pairs compliant to T568B wiring, per ANSI/TIA-568-C.0.
   4. Modular Patch Panels and Horizontal Management Panels
      a. Provide quantity of modular patch panels in the TR rooms to support termination of cables served from respective TR. Provide quantity of horizontal management panels as shown on the drawings.
      b. In the ER, provide one 2U horizontal manager in each server cabinet and one 2U horizontal manager between each patch panel in the network patching cabinets plus one manager at the top and bottom of each patching cabinet.
      c. Install and assemble modular patch panels and horizontal management panels according to the manufacturer’s instructions.
      d. Install the patch panels and the horizontal management panels as shown on the Drawings.
   5. Termination Sequence
      a. Backbone Cables: Terminate the backbone multipair cables to the modular patch panels 2 pairs per port. Terminate the 1st pair to pins 5/4 and the 2nd pair to pins 3/6 of the 1st port, etc. Leave pairs 25, 50, 75, and 100 open/unterminated.
      b. Horizontal Cables: Terminate the cables in sequential order using the link’s identifier starting at the top left and completing a panel before moving to the next panel below.

G. Cable Routing and Dressing at the Work Areas
   1. Provide 10 feet, minimum, sheathed cable slack – length not to exceed permanent link maximum length requirement. Place the slack within ceiling space neatly on a cable hanger.
   2. Routing to Furniture-feeds
      a. Route cables from primary or secondary pathway within ceiling through the furniture-feed pathway (stub within wall) into opening at bottom of furniture. Exercise caution to prevent scraping, cutting, or other damage to cable’s jacket.
b. Provide spiral wrap around cables from furniture-feed pathway to point where cables enter furniture.
c. Route cables from under-floor through pre-cut access floor panel into opening at bottom of furniture. Exercise caution to prevent scraping, cutting, or other damage to cable’s jacket.

H. Termination at the Work Areas
1. Provide device components, connectors, and accessories required for a complete installation. Install and assemble connectors, jacks, adapters, termination apparatus, accessories and associated management apparatus according to the manufacturer’s instructions.
2. Provide six inches, minimum, sheathed cable slack behind each workstation outlet faceplate. Coil the slack cable inside the raceway, within the wall, or in the junction box (if used), per the cabling manufacturer's installation standards.
3. Terminate cables and twisted pairs in accordance with manufacturer's latest installation requirements and ANSI/TIA-568-C.0 standard installation practices. Terminate cable pairs onto the connector compliant to T568B wiring, per ANSI/TIA-568-C.0.

I. Termination Apparatus (MPOE/EF)
1. Install the termination apparatus such that the bottom row of terminations is at a height as shown on the Drawings. If no height is shown, install bottom at 24” AFF (+/- 3”).
2. Provide accessories required for a complete installation.
3. Mount blocks plumb and square.

J. Building Entrance Splicing Systems
1. Provide entrance splice system as shown on the Drawings, including closure, end caps, splice modules, grounding components, and accessories required for a complete installation. Install splice closure and splice modules per manufacturer’s instructions using tools intended for the purpose.
2. Size enclosure based on splice bundle diameter, and size ends caps based on largest cable.
3. Include required accessories, such as collars, grommets, bushings, bonding connectors, etc. for a complete installation.
4. Thoroughly clean and separate binder groups prior to installing splice modules.
5. Apply sealant (such as B-sealant) to the end of the cable where the pairs exit the cable sheath – this to prevent water-blocking gel from leaking out the cable’s sheath.
6. Provide labels on each splice module and binder group in splice closure.
7. Grounding and Bonding
   a. Bond splice enclosure and cable shield to closet busbar using bonding conductor per manufacturer’s instructions and/or TIA-607 requirements.
   b. Provide 6 AWG bonding conductor up to 25 feet in length; if longer than 25 feet, size bonding conductor as 1000 circular mils per foot.
8. Fill unused end cap entry holes with appropriate plug (intended for purpose).
9. Attach splice enclosure to vertical cable runway on wall with metal straps.

K. Building Entrance Protection
1. Provide BEP system as shown on the Drawings, including terminals, modules, and accessories required for a complete installation. Install BEP per manufacturer’s instructions.
2. Install BEP terminals plumb and square, and at height shown on Drawings. If no height is shown, install such that bottom row is at 24” AFF (+/- 3”).
3. Grounding and Bonding
   a. Bond BEP terminal to TMGB in accordance with NEC Article 800, and follow the installation requirements described in Article 800.
   b. Provide 6 AWG bonding conductor up to 25 feet in length; if longer than 25 feet, size bonding conductor as 1000 circular mils per foot.
4. Labeling
   a. Provide and permanently affix label on the terminal’s cover.
   b. Provide label in the label holder at the terminal’s “outgoing” connection.
5. Provide quantity of protector modules to completely populate terminals.

L. Perform post-installation testing as described in the Telecommunication Testing specification (refer to Section 270811). Replace terminations and connectors not passing the required media test.

M. Patching Cords
1. Provide the following number of fiber optic patch cords
   a. 125% of all ports = 1 MM Station Patch Cord per port
   b. 125% of all ports = Network Patch Cord per port
2. Neatly dress patch cords within the horizontal and vertical management components. Store cord slack within the vertical management section.
3. Provide the appropriate length patch cord at each location so there is not an abundance of slack or the patch cord is not pulled tight.
4. Label both ends of each installed patch cord
5. Turn over all unused patch cords to the owner at the end of the project

3.04 LABELING

A. General Requirements
1. Labeling, identifier assignment, and label colors shall conform to ANSI/TIA/EIA-606-A Administration Standard and as approved by the Owner before installation.
2. Permanent labels with machine-generated text (hand written labels will not be accepted).

B. Label Formats
1. Horizontal Cable Labels
   a. Text Attributes: Black, 1/8” high, minimum, or #12 font size.
   b. Install labels on both ends of cables no more than 4” from the edge of the cable jacket. Install labels such that they are visible by a technician from a normal stance.
2. Backbone Cable Labels
   a. Text Attributes: Black, 1/8” high, minimum, or #12 font size.
   b. Install labels on both ends of cables no more than 4” from the edge of the cable jacket. Install labels such that they are visible by a technician from a normal stance.
3. Patch Panel Labels
a. Use modular patch panel labels included in the product packaging. Request approval by the Engineer for other labels.
b. Use a label color for the respective field type, per TIA/EIA-606.
c. Text Attributes: Black, 3/32” high, minimum, or #10 font size.

4. Termination Block Labels
   a. Use labels included in the product packaging. Any deviation from this requirement must be approved in writing by the Owner.
   b. Use a label color for the respective field type, per TIA/EIA-606-A.
   c. Text Attributes: Black, 3/32” high, minimum, or #10 font size.

5. Outlet Labels
   a. Use outlet labels included in the product packaging. Any deviation from this requirement must be approved in writing by the Owner.
   b. Label Background: White.
   c. Text Attributes: Black, 1/8” high, minimum, or #12 font size.
   d. Install label in the top label window. Leave the bottom label window blank.

C. Identifier Assignment

1. General: Separate label fields as specified by Owner.
2. Horizontal Cables
   a. Request standard from the Owner at the time of installation

3. Outlets
   a. Request standard from the Owner at the time of installation

4. Individual Ports at the Outlets
   a. Request standard from the Owner at the time of installation

5. Individual Termination Positions at Termination Blocks
   a. Request standard from the Owner at the time of installation

6. Individual Ports at Patch Panels
   a. Request standard from the Owner at the time of installation

D. Owner Labeling Standards (Supersedes all other requirements)

1. Each patch panel in a rack or cabinet will be labeled sequentially with a letter of the alphabet, starting at A.

2. Where multiple racks or cabinets are present, each rack will also be given a sequential identifier starting at the letter A.

3. Each port in a patch panel shall be labeled sequentially from 1, starting with the top- and left-most port. If labels are not already part of the patch panel, labels shall be affixed above each port.

4. Cables shall be labeled at each end clearly marking the connection the cable establishes. Additional labels should be included on segments of the cable that go through manholes and hand-holes.

5. Labels applied directly to a cable shall have a clear vinyl wrapping applied over the label and around the cable to permanently affix the label.

6. Where possible, labels shall be affixed above a jack in a patch panel. Where it is not possible to do so, pre-labeled numbered patch panels must be used and a cross-reference
map must be provided showing which cables are connected to which jacks in a patch panel.

7. Labels shall always be attached to the faceplates on Telecommunications Outlets in such a fashion as to reduce the chances of the label being separated from the faceplate.

8. All labels shall be machine printed.

9. Outside plant labels shall be totally waterproof, even when submerged.

10. Labels for telecommunications cables shall use the following form:

   Tcc-pjj

   where cc is the originating Telecommunications Closet number,

   p is the patch panel identifier,

   and jj is the jack number in the patch panel (including leading zeros if necessary).

   For example, “T01-B12” would be a cable that connects to port 12 of patch panel B in closet

11. If the cable is an inter-closet cabling (either inter- or intra-building), the originating closet will be the closet with the lower identification number.

3.05 FINAL INSPECTION AND CERTIFICATION

A. Punch the Work of this Section compliant to the requirements of Section 27 00 00.

B. Remove cables and replace with new those failing to meet the indicated standards and not passing the testing requirements of Section 270811 with no impact to cost and schedule. The Owner, will not accept the installation until testing has indicated a 100% availability of all cables and conductors. Any deviation from this requirement must be approved in writing by the Owner.

C. Comply with system acceptance and certification requirements of Section 27 00 00.

END OF SECTION
SECTION 28 00 00 - SECURITY BASIC REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY

A. This Section includes general administrative and procedural requirements for Division 28 and is intended to supplement, not supersede, the requirements specified in Division 1.

B. The requirements described herein include the following:
   1. References
   2. Definitions
   3. System Description
   4. Submittals
   5. Quality Assurance
   6. Product Delivery, Storage, and Handling
   7. Project Management and Coordination Services
   8. Warranty
   9. Maintenance

C. Related Sections:
   1. Consult other Sections, determine the extent and character of related work, and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable installation.
   2. Section 28 08 00 – Security System Acceptance Testing
   3. Section 28 13 00 – Access Control & Alarm Monitoring System

PART 2 - SECTION 28 23 00 – VIDEO SURVEILLANCE SYSTEM

1. Earthwork: Include trenching, backfilling, boring and soil compaction as required for the installation of underground conduit, in-grade pull boxes, vaults, and bollard foundations. Refer to Division 2.

2. Concrete Work: Include forming, steel bar reinforcing, cast-in-place concrete, finishing and grouting as required for underground conduit encasement, pedestal foundations, and curbs (also includes saw-cutting of existing slabs and grouting of conduits in saw-cut).

3. Miscellaneous Metal Work: Include fittings, brackets, backing, supports, rods, welding and pipe as required for support and bracing of raceways, equipment enclosures, cameras, and similar devices. Refer to Division 5.

4. Moisture Protection and Smoke Barrier Penetrations: Include membrane clamps, sheet metal flashing, counter flashing, caulking and sealant as required for waterproofing of conduit penetrations and sealing penetrations in or through fire walls, floors, ceiling slabs and foundation walls. Tape and make vapor tight penetrations through vapor barriers at slabs on grade. Refer to Division 7.

5. Locking Hardware: Include interface to electronic hardware and door controllers on security related doors. Refer to Division 8.

6. Access Panels and Doors: Required in walls, ceilings, and floors to provide access to security devices and equipment.
7. Painting: Include surface preparation, priming and finish coating as required for security cabinets, exposed conduit, pull and junction boxes, and devices where indicated as field painted in this Division. Refer to Division 9.

2.02 REFERENCES

A. General

1. Codes, standards, and industry manuals/guidelines listed by reference, including revisions by issuing authority, form a part of this specification section to extent indicated. Consider such codes and/or standards a part of this Specification as though fully repeated herein.

2. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

3. Reference to codes, standards, specifications and recommendations of technical societies, trade organizations and governmental agencies shall mean that latest edition of such publications adopted and published prior to submittal of the bid unless otherwise specifically stated.

B. Codes: Perform Work executed under this Section in accordance with applicable requirements of the latest edition of governing codes, rules and regulations including but not limited to the following minimum standards, whether statutory or not:

   1. United States Department of Labor (DOL) Regulations (Standards - 29 CFR)
      a. Part 1910 – Occupational Safety and Health Standards
   2. National Fire Protection Agency (NFPA)
      a. NFPA 70 – National Electrical Code (NEC)
      b. NFPA 75 – Protection of Information Technology Equipment
   3. Uniform Building Code (UBC)
   4. Uniform Fire Code (UFC)
   5. Uniform Mechanical Code (UMC)
   6. National, State, Local and other binding building and fire codes
   7. FCC Regulations:
      b. Part 68 – Connection of Terminal Equipment to the Telephone Network

C. Standards: Perform Work and furnish materials and equipment under Division 28 in accordance with the latest editions of the following standards as applicable:

      a. UL 294 – Access Control System Units
      b. UL 1076 – Proprietary Burglar Alarm Units and Systems
      c. UL 2044 – Commercial Closed-Circuit Television Equipment

2.03 DEFINITIONS

A. In addition to those Definitions of Division 1, the following list of terms as used in this specification defined as follows:

1. “Furnish”: To purchase, procure, acquire, and deliver complete with related accessories.

2. “Install”: To set in place, join, unite, fasten, link, attach, set up or otherwise connect together and test before turning over to the Owner, parts, items, or equipment supplied by contractor or others. Complete installation and make ready for regular operation.
3. “Provide”: To furnish, transport, install, erect, connect, test and turn over to the Owner, complete and ready for regular operation.
4. “Connect”: To install required patch cords, equipment cords, cross-connect wire, etc. to complete an electrical or optical circuit.
5. “As directed”: As directed or instructed by the Owner, or their authorized representative.
6. “Cabling”: A combination of cables, wire, cords, and connecting hardware (e.g., cables, conductor terminations, connectors, outlets, patch panels, blocks, and labeling).
8. “SJB”: Security Junction Box
10. “DCS”: Detention Control System
11. “IDS”: Intrusion Detection System
12. “NVR”: Network Video Recorder
13. “VSS”: Video Surveillance System

2.04 SYSTEM DESCRIPTION

A. In circumstances where the Specifications and Drawings conflict, the Drawings shall govern quantity and the Specifications shall govern quality.

2.05 SUBMITTALS

A. Submit required submittals to the General Contractor in the quantities and formats as required under the general contract. In the absence of requirements, provide as described in the following with reference to quantity and format.

B. Contractor Qualifications
   1. Resumes of the Project Manager, General Foreman, and Lead Technician(s) indicating role, years of experience, product certifications and training, listing of similar projects the individual performed the role proposed for this project along with client contact information for each.
   2. Certification letters stating the Contractor is an authorized reseller, installer, and extended warranty provider for the following systems:
      a. ACAMS manufacturer & certification level
      b. VSS manufacturer & certification level

C. Product Data
   1. Obtain written approval from the Engineer for the product data submittal prior to the release of materials and equipment purchase order and prior to installation.
   2. Quantity: Submit product data submittals as described in Division 1.
   3. Format:
      a. Minimum Format: Submit each product data submittal in an 8-1/2 x 11 inch folder. Product data submittal shall be in a 3-ring binder (or similar). If in a 3-ring binder, insert the submittal information the transparent front cover and spine pockets.
      b. Clearly label the cover and spine of each submittal with the following information:
         1) Client Name
         2) Project Name and Address
         3) Project Submittal Number
         4) Submittal Name (e.g., “Product Data Submittal for Video Surveillance System”)
5) Specification Section Number (e.g., “Section 28 23 00”)
6) Date of Submittal Format: <month> <day>, <year> (e.g., “January 1, 2014”)
7) Contractor Name
c. Include a Table of Contents at the beginning of the submittal that lists materials by article and paragraph number (e.g., “2.02-A Network Video Recorders”).
d. Include tabbed separators for improved navigation through the submittal.

4. Content:
   a. Cover Letter: Product data submittals shall include a cover letter stating that the submittal is in full compliance with the requirements of the Contract Documents. Sign (and stamped, if applicable) cover letter and list items and data submitted. Have the person who prepared the submittal sign the document as well. Failure to comply with this requirement shall constitute grounds for rejection of submittal.
   b. Product Information: Product Data submittal shall consist of manufacturer's technical data, product literature, "catalog cuts", data sheets, specifications, and block wiring diagrams (if necessary). This data shall clearly describe the product’s characteristics, physical and dimensional information, electrical performance data, materials used in fabrication, material color & finish, and other relevant information such as test data, typical usage examples, independent test agency information, and storage requirements. Clearly indicate by arrows or brackets precisely what is being submitted on and those optional accessories, which are included and those which are excluded. At a minimum, include products listed in the Division 28 specifications. Include relevant products that will be installed, which are not listed in the specifications.
   c. Re-submittals: Provide a cover letter with the re-submittal that lists the action taken and revisions made to each product submittal in response to Submittal Review Comments. No review shall take place for any re-submittal packages that is not accompanied by this cover letter. Failure to include this cover letter will constitute rejection of the re-submittal package.

D. Shop Drawings
   1. Obtain written approval from the Engineer for the shop-drawings submittal prior to the release of materials and equipment purchase order and prior to installation.
   2. Quantity and Media: Submit shop-drawings as described in Division 1.
   3. Format:
      a. Produce shop drawings using AutoCAD, or other computer design application that can save files to AutoCAD-compatible files.
      b. Use the same size drawing sheet as the drawings of the Contract Documents.
      c. Text: minimum of 3/32” high when plotted at full size.
      d. Screen background information.
      e. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.
      f. Scaling:
         1) Scale floor plans at 1/8”=1’-0”
         2) Scale enlarged room plans at 1/4”=1’-0”
         3) Scale wall elevations at 1”=1’-0”
   4. Content:
      a. Submit shop drawings that represent proposed installation of security system.
      b. Floor Plans: Scale floor plans at 1/8”=1’-0”. Floor plans shall show:
         1) Locations and identifiers of security devices.
         2) Size, quantity, location and proposed routes of security cabling.
3) Size, quantity, location, and routes of pathways (such as cable trays, cable basket, conduits, cable hangers, and other cable support devices).

c. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices.

d. Schedules: Provide schedules for devices and control panels that show each point ID with a description of the connected devices.

e. Block Diagram/Riser Diagram: Show the devices, conduit, wire types, and sizes between them, including cabling interties between termination hardware.

f. Proposed mounting details

E. As-Built Drawings

1. Quantity and Media: Submit as-built drawings as described in Division 1.

2. Format:
   a. Produce as-built drawings using AutoCAD, or other computer design application that can save files to AutoCAD-compatible files.
   b. Use the sheet size as the drawings of the Contract Documents, and use the project title block.
   c. Text: minimum of 3/32” high when plotted at full size.
   d. Use symbols identical to the symbols shown on the Drawings.
   e. Screen background information.
   f. Plot system components (devices, cable routes, etc.) and text at a sufficient line weight to stand out against background information.

3. Content:
   a. Submit as-built drawings that fully represent actual installed conditions and that incorporate modifications made during the course of construction.
   b. Floor Plans: Scale floor plans at 1/8”=1'-0”. Floor plans shall show:
      1) Locations and identifiers of security devices.
      2) Size, quantity, location and proposed routes of security cabling.
      3) Size, quantity, location, and routes of pathways (such as cable trays, cable basket, conduits, cable hangers, and other cable support devices).
   c. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices.
   d. Schedules: Provide schedules for devices and control panels that show each point ID with a description of the connected devices.
   e. Block Diagram/Riser Diagram: Show the devices, conduit, wire types, and sizes between them, including cabling interties between termination hardware.
   f. Custom mounting details

F. Operation and Maintenance (O&M) Manuals

1. Quantity: Submit quantity of O&M Manuals as described in Division 1.

2. Format:
   a. Submit each O & M Manual in a white, 3-ring binder with front cover and spine clear pockets for insertion of the project information.
   b. Clearly label the cover of each O&M Manual with the following information:
      1) Client Name
      2) Project Name and Address
      3) Manual Name (e.g., “Operation and Maintenance Manual for Video Surveillance System”)
      4) Date of Submittal Format: <month> <day>, <year> (e.g., “January 1, 2010”)
5) Contractor Name
   c. Include a Table of Contents at the beginning that lists the contents.
   d. Include tabbed separators for improved navigation through the manual.

3. Content:
   a. 11”x17” prints of as-built drawings, as described above
   b. Manufacturer’s original catalog information sheets for each component provided under applicable Section (typically, this is similar to the accepted product data submittal)
   c. Warranty certificate from the manufacturer and the Contractor
   d. Manufacturer’s instructions for system or component use
   e. Instructions and requirements for maintenance and warranty issues

4. Contents shall include requirements and methods for maintaining installed products.

2.06 QUALITY ASSURANCE

A. Contractor Qualifications
   1. A current, active, and valid Texas State Contractors License
   2. Minimum five years experience in installation and service of access control, video surveillance, and intrusion detection systems.
   3. Minimum five completed projects similar to scope and cost.
   4. Evidence of technicians qualified for the work in the form of current manufacturer’s training certification

B. Materials
   1. Materials, support hardware, equipment, parts comprising units, etc., shall be new, unused, without defects and of current manufacturer, materials
   2. Use specified products and applications, unless otherwise submitted and approved in writing.

C. Regulatory Requirements
   1. Work and materials shall conform to the latest rules of National Board of Fire Underwriters wherever such standards have been established and shall conform to the regulations of the State Fire Marshal, OSHA and the codes of the governing local municipalities. Work under Division 28 shall confirm to the most stringent of the applicable codes.
   2. Provide the quality identified within these Specifications and Drawings when codes, standards, regulations, etc. allow Work of lesser quality or extent. The Contract Documents address the minimum requirements for construction.

D. Drawings
   1. Follow the general layout shown on the Drawings except where other Work may conflict with the Drawings.
   2. Drawings for the Work within this Division are essentially diagrammatic within the constraints of the symbology applied.
   3. The Drawings do not fully represent the entire installation for the security system. Drawings indicate the general route for the cables and the location of outlets. The Drawings might not expressly show every conduit, sleeve, hanger, etc., but a complete system is required.


2.07 PROJECT MANAGEMENT AND COORDINATION SERVICES

A. Project Management and Coordination Services
   1. Provide a project manager for the duration of the project to coordinate this Work with other trades. Coordination services, procedures and documentation responsibility include, but are not limited to, the items listed in this section.
   2. Review of Shop Drawings Prepared by Other Subcontractors:
      a. Obtain copies of shop drawings for equipment provided by others that require telecommunication service connections or interface with Work.
      b. Perform a thorough review of the shop drawings to confirm compliance with the service requirements contained in the Division 28 contract documents. Document discrepancies or deviations as follows:
         1) Prepare memo summarizing the discrepancy
         2) Submit a copy of the specific shop drawing, indicating via cloud, the discrepancy
      c. Prepare and maintain a shop drawing review log indicating the following information:
         1) Shop drawing number and brief description of the system/material
         2) Date of the review
         3) Name of the individual performing the review
         4) Indication if follow-up coordination is required

B. Role of the Engineer
   1. During the construction phase of the project, the Engineer will work with the Contractor to provide interpretation and clarification of project contract documents, reply to (and “process”) relevant Requests for Information (RFIs), and act as an interface between the Contractor and the Owner.
   2. The Owner has retained the Engineer’s services to observe the Work for general compliance with the Contract Documents and to ensure that the installation meets the design intent of the system.
   3. In general, the Engineer will participate during the construction phase as follows:
      a. Review product data and shop drawings submittals for general compliance with the contract drawings and specifications.
      b. Review changes as they arise, and confirm that the proposed solutions maintain the intended functionality of the system.
      c. Interpret field problems for Owner, and translate between Owner and Construction Team.
      d. Review the testing procedures to confirm compliance with industry-accepted practices.

C. Use of CAD Files
   1. Should the Contractor need the Engineer’s CAD files to produce shop drawings and/or as-built drawings, the Engineer requires the Contractor sign a CAD files release agreement.

2.08 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery
   1. Do not deliver security system components to the site until protected storage space is available. Storage outdoors covered by rainproof material is not acceptable.
   2. Replace equipment damaged during shipping and return to manufacturer at no cost to the Owner.
B. Storage
1. Store materials in a clean, dry, ventilated space free from temperature extremes.
2. Maintain factory wrapping or provide a heavy canvas/plastic cover to protect units from dirt, water, construction debris, and traffic.
3. Provide heat where required to prevent condensation or temperature related damage.

C. Handling
1. Handle in accordance with manufacturer's written instructions.
2. Prevent internal component damage, breakage, denting and scoring. Do not install damaged equipment. Replace damaged equipment and return equipment to manufacturer.

2.09 WARRANTY

A. Provide the Security System as described in this specification with a one-year parts and service warranty at no additional cost to the Owner.

B. Include in the warranty package, at a minimum, the following:
   1. Software support agreement for the ACAMS and VSS
   2. Software upgrades and patches
   3. Labor to install software upgrades and patches necessary to maintain the latest version
   4. Emergency service on regular working hour basis
   5. Service by factory trained and employed service representatives of system manufacturer

C. Maintain regular service facilities and provide a qualified technician familiar with this work at the site within four (4) hours of receipt of a notice of malfunction including weekends and holidays. Provide material, devices equipment and personnel necessary for repairs. Install approved temporary, alternate equipment if required by the Owner, complete and operational within twenty four (24) hours after notification of a malfunction, at no additional cost.

D. Conduct warranty repairs and service at the job site unless in violation of manufacturer's warranty; in the latter event, provide substitute systems, equipment and/or devices, acceptable to the Owner, for the duration of such off-site repairs. Transport warranty substitute and/or test systems, equipment, devices, material, parts and personnel to and from the job site at no additional cost.

2.10 MAINTENANCE

A. Extra Materials
   1. Deliver extra materials to a secured location determined by the Owner.
   2. Provide a complete Bill of Materials listing quantities, part numbers, and descriptions for each device for the Owner to sign indicating receipt of equipment.
   3. Provide new and unused spare parts in their original packing materials upon delivery.

B. Maintenance Service
   1. For the first year of service, conduct quarterly system performance review meetings to review system operation problems and/or defects that occurred during the preceding 3 months. During these performance review meetings, perform the following:
a. Visual checks and operational tests of the central processor, local processors, monitors, keyboards, system printers, peripheral equipment, ACAMS equipment, power supplies, and electrical and mechanical controls
b. Clean system equipment, including interior and exterior surfaces
c. Perform diagnostics on equipment
d. Check and calibrate each device
e. Run system software and correct diagnosed problems
f. Resolve previous outstanding problems
2. Provide software and firmware updates issued free of charge by the manufacturer.

PART 3 - PRODUCTS

3.01 GENERAL

A. Material and equipment specified herein have been selected as the basis of acceptable quality and performance and have been coordinated to function as components of the included systems. Where a particular material, device, equipment or system is specified directly, the current manufacturer's specification for same is a part of these specifications, as if completely elaborated herein.

B. Use standard, regularly manufactured, materials and equipment for this and/or other similar systems, and not custom designed especially for this project. Provide systems and components thoroughly tested and proven in actual use. Provide subsystems of one manufacturer.

3.02 SUBSTITUTIONS

A. Conform to the general requirements and procedure outlined in Division 1 in the Request for Substitution.

B. Only one substitution allowed for each product specified.

C. Where products are noted as "or equal", a product of equivalent design, construction, and performance will be considered. Submit product data – catalog cuts, product information, and pertinent test data – required to substantiate that the product is in fact equivalent to that specified. The burden of proof rest with the Contractor that the substituted product is equivalent to the specified product.

D. Manufacturers' names and model numbers used in conjunction with materials, processes or equipment included in the Contract Documents are used to establish standards of quality, utility and appearance. Materials, processes or equipment that, in the opinion of the Engineer, are equivalent in quality, utility and appearance will be approved as substitutions to that specified when "or equal" follows the manufacturers' names or model number(s).
E. When the Engineer accepts a substitution in writing, it is with the understanding that the Contractor guarantees the substituted product, component, article, or material to be equivalent to the one specified and dimensioned to fit within the construction according to contract documents. Do not provide substituted material, processes, or equipment without written authorization from the Engineer. Assumptions on the acceptability of a proposed substitution, prior to acceptance by the Engineer, are at the sole risk of the Contractor.

F. Approved substitutions shall not relieve the Contractor of responsibilities for the proper execution of the Work, or from provisions of the Specifications.

G. Pay expenses, without additional charge to the Owner, in connection with substitution materials, processes and equipment, including the effect of substitution on self, subcontractor's or other Contractor's work.

PART 4 - EXECUTION

4.01 EXAMINATION

A. Conditions: Verify existing conditions, which have been previously provided under other sections, are acceptable for product installation in accordance with manufacturer's instructions.

B. Pathways: Verify that pathways and supporting devices, which have been previously provided under other sections, are properly installed, and that temporary supports and devices have been removed.

C. Field Measurements: Verify dimensions of pathways, including length of pathways. For example, “True Tape” the conduits to verify cable distances.

4.02 FIELD QUALITY CONTROL

A. Staffing: Provide a qualified foreman who is in charge of the Work and who is present at the job site at times Work is being performed. Perform the Work using skilled technicians under the direction of the foreman. Supervise the work force executing the Work. Perform the installation within the restraints of the construction schedule. Do not change the supervisor during the project without prior written approval from the Owner.

B. Inspection: Perform inspection after installation. Keep areas of work accessible and notify code authorities, or designated inspectors, of work completion released for inspection. Document completion and inspection as required.

4.03 INSTALLATION

A. Perform this work in accordance with acknowledged industry and professional standards and practices and the procedures specified herein.
B. Provide a complete, operating system. Include devices specified including basic components and accessories, interconnecting wiring and other equipment and installation devices necessary for a complete system as specified.

C. Manufacturer's Instructions:
1. Comply with manufacturer's product data, including product technical bulletins, product catalog installation instructions, and product carton instructions for installation.
2. Maintain jobsite file of Material Safety Data Sheets (MSDS) for each product delivered to jobsite.

D. Boxes, Panels, and Enclosures
1. Install boxes, panels, and enclosures square and plumb.
2. Set "flush mounted" units with the face of the cover, bezel or escutcheon in the same plane as the surrounding finished surface.
3. Mount boxes, panels and trim so that there are no gaps, cracks or obvious lines between the trim and the adjacent finished surface and ready them to receive final finish, as applicable.
4. Install insulating terminations in signal circuit boxes, panels, wireways or enclosures.

E. Painting
1. Custom paint devices as indicated on the drawings.

4.04 REPAIR/RESTORATION

A. Replace or repair work completed by others that you deface or destroy, at not cost to the Owner.

B. Punch List:
1. Inspect installed work in conjunction with the General Contractor and develop a punch list for items needing correction.
2. Provide punch list to Engineer for review prior to performing punch walk with the Engineer.

C. Re-Installation:
1. Make changes to the system such that defects in workmanship are correct and cables and the associated termination hardware passes the minimum test requirements.
2. Repair defects prior to system acceptance.

D. Painting: Repaint surfaces altered during installation of the security system to match previous conditions.

4.05 CLEANING

A. Remove temporary coverings and protection of adjacent work areas. Remove unused products, debris, spills, or other excess materials. Remove installation equipment.

B. Leave finished work and adjacent surfaces in neat, clean condition with no evidence of damage.

C. Repair or replace damaged installed products.
D. Legally dispose of debris.

E. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.

END OF SECTION 28 00 00
PART 1 - GENERAL

1.01 GENERAL

A. Furnish engineering, labor, materials, apparatus, tools, equipment, and transportation required to thoroughly test the completed security system installation as described in these specifications.

B. Full testing of a completed security system which includes:
   1. Develop, submit, and obtain Engineer’s approval of security system Pre-Functional and Functional testing forms.
   2. Complete 100% Pre-Functional test of the security system. Submit Pre-Functional testing documentation reflecting that all security devices, cabling, locking hardware, power, interfaces to other systems, network switches, servers, workstations, and other components required for a completely functional security system are provided per project documents.
   3. Complete 100% Functional test of the security system. Submit Functional testing documentation reflecting that all security equipment, components, interfaces, and programming are functioning correctly per project documents. Upon receiving approval of functional testing documentation, schedule final acceptance testing activities to be witnessed by Engineer and/or Owner.
   4. Demonstrate 100% security system functionality to the Engineer and Owner’s IT and Security representatives. Document testing activities and submit with final As-Built drawing.

1.02 SUMMARY OF SYSTEM COMMISSIONING ACTIVITIES

A. Overview
   1. The purpose of system commissioning is to ensure the security system operates properly when it is needed most. Security systems are very complex from both an equipment and programming standpoint, and thorough testing is necessary to ensure correct operation.
   2. Perform testing activities after-hours or on weekends when the system is “quiet” and the building is generally unoccupied. This will minimize the amount of irrelevant activity in the system activity reports that will be used as a record of the pre and final test results.

B. Pre-Functional Test
   1. Perform a 100% pre-functional test of system aspects to verify correct operation prior to scheduling the final test. The pre-test will help to make the final test run smoothly when demonstrating the system’s operation to the Engineer and Owner’s IT and Security representatives.
   2. Document the results of the pre-test using the approved test forms and submit a copy to the Engineer along with the system activity reports.

C. Functional Test
1. Perform a 100% pre-functional test of system aspects to verify correct operation prior to scheduling the final test. The pre-test will help to make the final test run smoothly when demonstrating the system’s operation to the Engineer and Owner’s IT and Security representatives.

2. Document the results of the pre-test using the approved test forms and submit a copy to the Engineer along with the system activity reports.

D. Final Acceptance Test

1. Perform a final test of the system in the presence of the Engineer and Owner’s IT and Security representatives to demonstrate correct operation of the security system.

1.03 SUBMITTALS

A. Operation and Maintenance Manuals

1. Functional Design Manual: Includes a detailed explanation of the operation of the system.

2. Hardware Manual which includes:
   a. Pictorial parts list and part numbers
   b. Pictorial and schematic electrical drawings of wiring systems, including devices, control panels, instrumentation and annunciators
   c. Telephone numbers for the authorized parts and service distributors
   d. Include service bulletins

3. Software Manual which includes:
   a. Use of system and applications software
   b. Initialization, start-up, and shut down procedures
   c. Alarm Reports

4. Operator’s Manual which fully explains procedures and instructions for the operation of the system and includes:
   a. Computers and peripherals
   b. System start up and shut down procedures
   c. Use of system, command, and applications software
   d. Recovery and restart procedures
   e. Graphic alarm presentation
   f. Use of report generator and generation of reports
   g. Data entry operator commands
   h. Alarm messages and reprinting formats
   i. System access requirements

5. Maintenance Manual which includes:
   a. Instructions for routine maintenance listed for each component, and a multi-page summary of component’s routine maintenance requirements.
   b. Detailed instructions for repair of the security system.
   c. A summary of the software licenses, including license numbers, quantity of clients, summary of the software options provided and database capabilities.
   d. A summary of the TCP/IP address used and which system component they are associated with. Include the gateway address, subnet mask, DNS server, and host name information.

6. Test Results Manual, which includes the document results of tests, required under this Specification, organized by System, Floor, and Door.
7. Record Drawings Manual which includes 11”x17” prints of record drawings as described below.

B. Record Drawings
   1. Drawings to fully represent installed conditions including actual locations of devices, actual cable and terminal block numbering, and correct wire sizing as well as routing. Record changes in the work during the course of construction on blue or black line prints.
   2. Include drawings submitted as part of the Shop Drawing package, plus additional information required to accurately document installed conditions.
   3. Include the following additional information:
      a. Device addresses & IP address information.
      b. Settings for each camera (lens specs, mm setting, auto shutter setting, and other available camera settings, etc.)
   4. Final acceptance will not be made until the Engineer approves the record drawings.

PART 2 - PRODUCTS – NOT USED

PART 3 - EXECUTION

3.01 SCHEDULING
   A. Coordinate security commissioning with the General Contractor and provide specific information on pre-test and final-testing activities to be entered into the overall project construction schedule.

3.02 TESTING REQUIREMENTS
   A. Site Tests
      1. Perform a 100% pretest of the system prior to final testing by the Engineer. Provide the Engineer with a minimum of a 5 day notice prior to scheduling testing.
      2. At the conclusion of the work on a floor, test the system on that floor to verify proper operation and reporting of devices.
      3. Work with the door hardware supplier to resolve electric hardware failures and door alignment/closure problems.
      4. At the completion of the work, test the entire system to verify proper operation. At a minimum, include these tests:

         a. Camera Test: Review cameras for proper coverage, resolution, frame rate, and overall quality of image.
b. Video Management Software Test: Test recording system for correct programming, alarms, and event retrieval. Verify integration with ACAMS and video analytics software. Verify functionality at each client workstation. Verify graphical mapping screens and devices.

c. Video Virtual Matrix Test: Test functionality of virtual matrix switch for correct programming, operation, and alarm call up. Verify functionality to push video streams on-demand to any monitor and any client workstation.

d. Video Appliance Test: Test functionality of servers and storage appliances for system parity and bandwidth load balancing. Verify RAID-6x functionality by demonstrating 5 simultaneous drive failures and 1 server failure.

e. Battery and UPS Load Test: Disconnect AC power to security system components to verify battery operation functions and system remains fully operational.

B. Test Preparation
1. Provide device identification numbers that differ from or were not included on the original contract drawing set.
2. Provide a complete systems point list.
3. Provide paper and toner for the printer so that an event log can be printed out and attached to the test reports as verification of test sequence and systems response.
4. During testing, provide a minimum of three technicians familiar with the installation to assist with the test. Stage the technicians as follows: one at the host, one at the device being tested, and one runner responsible to furnishing tools, step ladders, etc.
5. Provide radios for use by the Engineer and Owner during testing.
6. Provide pre-programmed access cards for use during testing. Provide one card for each access level.

3.03 TEST PROCEDURES

A. Refer to the test forms for testing procedures for each type of device/system.

3.04 DOCUMENTATION

A. Provide a full-sized drawing package containing a detailed wiring diagram (layout of equipment/elevation, complete parts list, and a complete wiring diagram for each access control panel) for each SEC location in the IDF rooms. Fold the diagram and place it inside a clear plastic pocket affixed to the inside door of the SEC.

B. Provide a service log on the inside door of each SEC. Include columns for the following information: date of service, description of work performed, service technician(s), and service company in the service log. Place the service log inside a separate clear plastic pocket affixed to the inside door of the SEC.
3.05 DEMONSTRATION

A. On completion of the acceptance test, instruct the owner's representatives, at a time convenient to them, in the operation and testing of the system.

B. Utilize the database for the project during training to give the users a project specific example to learn from.

C. Provide a minimum of 80 hours of on-site training by a factory trained representative for each of the following systems:
   1. Access Control & Alarm Monitoring System
   2. Video Surveillance System
      a. Network Video Recording System
      b. Network Video Analytics System
      c. Network Video Servers and Storage Appliances
   3. Infant Protection System
   4. Detention Control System
   5. Intercom System

D. Maintain a sign in sheet with names and dates of persons trained and forwarded to owner upon completion of training.

E. Provide for four (4) Owner’s representatives to attend factory certification training (off-site) for both the following systems:
   1. Access Control & Alarm Monitoring System
   2. Video Surveillance System

END OF SECTION 28 08 00
PART 1 - GENERAL

1.01 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction and special or occasional services as required to make a complete working Access Control & Alarm Monitoring system installation, as described in these specifications.

B. Section Includes:
   1. ACAMS software licenses
   2. ACAMS control panels, input/output modules, and card readers
   3. ACAMS power supplies
   4. Alarm initiating devices, including: magnetic switch contacts, request-to-exit sensors, duress buttons, and general alarm points
   5. Integration with the VSS and other security subsystems to allow bi-directional communication with one another
   6. Interface to electric door hardware and ADA door operators
   7. Interface to fire/life-safety system

C. Products Furnished and Installed Under another Section:
   1. 120V power
   2. Conduit and junction boxes
   3. ADA door operators and push buttons
   4. Fire/life-safety system interface relays
   5. Network connectivity for ACAMS devices via Owner’s local/wide area network

D. Related Sections:
   1. Consult other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
   2. Section 28 00 00 – Security Basic Requirements: for submittal formats, warranty, general product requirements, and installation requirements.
   3. Section 28 08 00 – Security System Acceptance Testing: for testing requirements.
   4. Section 28 23 00 – Video Surveillance System: for interface requirement with the ACAMS.

1.02 SYSTEM DESCRIPTION

A. Overview
   1. The ACAMS is a distributed network of control panels connected to and programmed from a host server and client workstations.
   2. The ACAMS is utilized for electronically controlling access to off-stage and on-stage areas, lounges, medication and supply rooms, storage rooms, and other staff-only spaces. The system also utilizes other software interfaces by other projects and
3. The ACAMS consists of redundant host servers located in the primary and secondary MDF rooms, client workstations, control panels, card readers, and alarm initiating devices. The host server communicates with the field panels via the Owner’s local/wide area network.

4. Refer to Division 08 for door schedule and product information. All products listed in Division 08 to take precedence over products listed in this section.

B. Access Control & Alarm Monitoring System
   1. Provide ACAMS software and associated licenses to support the devices shown on the project drawings.
   2. Provide web browser client license (thin client) to allow for remote viewing on other workstations and or mobile devices.
   3. Provide ACAMS control panels located in the IDF rooms as indicated on project drawings.
      Panels support up to 64 card readers each with locking control outputs and multiple general purpose input/output modules for automation.
   4. Provide smart card readers as indicated on project drawings.
   5. Provide interface to latch position switch (LX) and request-to-exit (RX) switch within electrified door hardware for card reader controlled doors. Provide alarm contacts and request-to-exit motion detectors for card reader doors that do not contain LX and RX sensors within the electrified hardware set. Provide continuous updating of security details to match revised Div. 8 information as needed throughout the duration of the project. Refer to Section 08 71 00 – Door Hardware for additional requirements.
   6. Provide alarm contacts for non-card reader controller perimeter doors as indicated on project drawings.
   7. Provide 12/24VDC ACAMS device and lock power supplies as indicated on project drawings.
   8. Provide battery backup of system components and power supplies.

C. ACAMS Integration Requirements
   1. ACAMs alarm events over to the video system for video call up features to work on the video system.

D. Interface to Fire/Life-Safety System
   1. Coordinate with Fire/Life-Safety system contractor to automatically drop power from stairwell, elevator vestibule lobby, and other access controlled doors within the path of egress upon alarm activation of the Fire/Life-Safety system.

E. Tamper Monitoring
   1. Provide additional monitor input points for monitoring the following:
      a. Tamper switches located within each security equipment enclosure (use unsupervised inputs for this purpose).
      b. Supervision of power supplies and batteries (use unsupervised inputs for this purpose).
      c. All unused dedicated tampers and AC power fail inputs must be jumpered to prevent false activation alarms.

1.03 SUBMITTALS
A. Contractor Qualifications: Submit certification letters for the manufacturer of the ACAMS.

B. Product Data: Submit product information for components specified herein.

C. Shop Drawings:
   1. Device placement on floor plans
   2. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices between the following:
      a. ACAMS control panel
      b. ACAMS card reader and input/output modules
      c. ACAMS power supplies
      d. Card Readers
      e. Alarm contacts and request-to-exit sensors
      f. Local audible alarms
      g. Interface to electrified door hardware
      h. Interface to fire/life-safety system
      i. Cable conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)

   3. Schedules: Provide schedules for ACAMS control panels that show each point ID with a description of the connected devices.
   4. Block Diagram/Riser Diagram: Show the ACAMS components, conduit, wire types, and sizes between them, including cabling interties between termination hardware.
   5. Custom mounting details

PART 2 - PRODUCTS

2.01 ACAMS SOFTWARE & SERVER
   A. General
      1. Designed for unlimited scalability with a multi-tier architecture to allow for centralized monitoring and control of buildings within the Owner’s campus and future remote sites.

2.02 ACAMS CONTROLLERS
   A. General
      1. An intelligent controller with integrated battery backup, database, and communication ports that supports 64 card readers.
      2. Supports multiple communication channels to which a variety of devices can connect.
      3. Supports hardware modules used for additional memory and/or for future feature enhancements.
      4. Functions provided include:
         a. Central control for attached devices and addressable modules
         b. Makes decisions for access
         c. Responds to monitor activity
         d. Receives input to control its decision making
         e. Reports activity to other devices
B. Features
1. Supports HID proximity, MIFARE, and DESFire card reader formats
2. Supports flash upgrades for firmware updates
3. Utilizes an onboard Ethernet NIC
4. Global input/output and anti-passback functionality
5. Capable of utilizing keypad commands to activate/deactivate events

C. Supports RS-485 connectivity to addressable modules:
1. Input Module: Supports 4 Class A supervised input points
2. Output Module: Supports 4 Form C dry contact relays
3. Reader Interface Module: Supports 2 card readers with associated alarm contacts, request-to- exit devices, and lock outputs configured in Fail Secure mode.

D. Manufacturer
1. S2 Security
   a. #EXT-64-MW NetBox Extreme access control and event monitoring system
   b. #S2-NN-E2R-WM-ACM Network Node
   c. #S2-ACM Application Blade

2.03 EQUIPMENT ENCLOSURES

A. Security Equipment Cabinets
1. Type: NEMA type 1 enclosure
2. Manufacturer
   a. Life Safety Power
      1) #FPO150/250-2C8P3D8PE8M2/P16-A
      2) #FPO150-B100C8P2D8PE6M/P8-1
      3) #FPO76-B100C4PD8PE4M/T4-A

B. Slotted Wiring Duct
1. Type: Lead-free PVC with narrow finger design
2. Size: 1” x 1” minimum
3. Color: Light gray
4. Manufacturer
   a. Panduit
      1) #Type-F narrow slot wiring duct
   b. Or equal

2.04 WIREWAYS

A. General
1. Provide screw cover wireway sections with open top assembly as shown on Security drawings.
2. Provide closure plates to secure end of wireway sections.

B. Screw Cover Gutter Wireways
1. Type: NEMA type 1 enclosure
2. Size: 4” x 4” x 48” minimum
3. Finish: ANSI 61 gray polyester powder paint finish inside and out

C. Manufacturer
1. Hoffman
   a. #F44T148GVP lay-in painted wireway without knockouts
   b. #A44GCPNK closure plate without knockouts
2. Or equal

2.05 CARD READERS (REFER TO DIVISION 8)

2.06 MAGNETIC CONTACT SWITCHES

A. Wood, Steel, and Hollow Metal Doors
1. General
   a. Mounting: Recessed
   b. Contacts: Single Pole, Single Throw
   c. Gap Distance: 0.5” maximum
   d. All exterior doors to include resistor and are to be supervised
2. Manufacturer
   a. Interlogix
      1) #1078C 3/4” alarm contact switch
   b. Or equal

2.07 DURESS BUTTONS

A. Under-Counter
1. General
   a. Actuating lever, housing, and cover plate made of ABS fire-retardant plastic
   b. Latching circuit with integrated LED
   c. Contact: Normally Open or Normally Closed electrical loop, SPDT
   d. Operating Voltage: 12VDC
2. Manufacturer
   a. Interlogix
      1) #3040 panic switch

2.08 LOCAL AUDIBLE ALARMS

A. General
1. Panel operating voltage selectable 12 or 24VDC at 150mA.
2. Keyswitch operation using rim cylinder provided by Owner to match existing standard.
3. Utilizes 80 Db horn.
4. Input points for door switch, alarm shunt, door status, tamper switch, and key switch override.
5. Output points for door propped alarm, intrusion alarm, door status, tamper switch, and key switch override.
6. Timers for access period, warning period, and auto reset.
7. Tamper switch to detect the removal of the unit from the electrical back box.
B. Manufacturer
   a. Designed Security Inc
      1) #4200 local alarm sounder
   b. Or Equal

2.09 REQUEST-TO-EXIT BUTTONS

A. Wall Mount
   1. General
      a. Pneumatic adjustable timer button
      b. Latching circuit
      c. Unique protective housing to avoid accidental activation
      d. Dip switch adjustment

B. Manufacturer
   a. ASSA ABLOY
      1) #TS-60
   b. Or equal

2.010 REQUEST-TO-EXIT MOTION SENSORS

A. General
   1. Power: 12 or 24VDC, 35mA
   2. Relay Output: 2 form “C” contacts
   3. Adjustable relay latch time
   4. Programmable retrigger or non-retrigger mode
   5. Programmable Fail Safe or Fail Secure Modes
   6. Radio Frequency Interference (RFI) Immunity range from 26 to 1,000 MHz at 50 v/m

B. Manufacturer
   a. Kantech Systems (no substitutes)
      1) #T.REX-LT-NL request-to-exit sensor

2.011 ACAMS POWER SUPPLIES (Included in security enclosure)

2.012 BATTERIES

A. General:
   1. Voltage: 12.00
   2. Amps: 12.00
   3. Chemistry: SLA or VRLA valve regulated
   4. Termination: Spade protected terminals

B. Manufacturer:
   a. Yuasa
      1) #RE12-12 sealed lead acid 12V 12Ah battery
   b. Or equal
PART 3 - EXECUTION

3.01 INSTALLATION

A. ACAMS Client Software
   1. Only reader license software is to be furnished for this section of the project.

B. ACAMS Control Panels
   1. Place power supply and associated hardware in same location.
   2. Provide designated resistors at device end of line per manufacturer’s EOL recommendation to provide four-state supervision of security device and cabling.
   3. Provide EOL supervision for alarm contacts, local alarm sounders, motion detectors, glass break detectors, help/duress buttons, and other designated security devices connected to the ACAMS and IDS.
   4. Provide the following states of supervision:
      a. Contact closed = Secure
      b. Contact open = Alarm
      c. Short circuit = Line fault
      d. Open circuit = Line fault

C. Card Readers
   1. Wire the card reader’s multi-color LED to indicate the following status of the door.
      a. Red status indicates the door is secure (locked).
      b. Green status indicates the door is unsecured (unlocked).
   2. The card reader to produce an audible beep tone to indicate to the user:
      a. The card was read and/or access was denied.
      b. Door is being held open and needs to be closed.

D. Door Hardware
   1. Route power to electrically controlled locks on life-safety doors through fire alarm output to automatically unlock the door upon activation of Fire/Life-Safety system. Connect fire alarm output to the disconnect relay on the associated 24VDC lock power supply.
   2. Setup and conduct a door hardware coordination meeting.
   3. Coordinate the installation and termination of the security cable with the installation of the electric door hardware and transfer hinge.
   4. Provide cable and terminate wires to delayed egress devices for monitoring activation of delayed egress by the ACAMS system.

E. Door Contacts
   1. Install on protected (secured) side of door.
   2. Install 6” from leading edge at top of door.

F. Duress Buttons
   1. Mount duress buttons under work desks as indicated on the project drawings.
   2. Coordinate with architect and casework contractor to field determine exact placement prior to installation.

3.02 PROGRAMMING
A. Prior to the completion of construction, schedule a meeting with the Owner’s IT and Security representatives to determine the programming criteria. Discuss the following:
   1. Access card levels and door groupings
   2. Alarm priority levels
   3. Schedules and time codes
   4. Holidays and holiday types (priorities)
   5. Action/responses from individual input points
   6. Standard and custom (expanded) reports
   7. Defining alarm messages and standard response messages applicable to site
   8. Routing of alarm points to selected mobile phones
   9. Routing of alarm points to operator’s workstations, printers, and history files
   10. Coordinate implementation of graphics with Owner. Clean up (remove grid lines, sheet notes, clouds, etc) CAD drawing backgrounds for use as graphic maps clearly showing security devices. Develop sample graphic complete with icons and text. Alarms to appear on building floor plans depicting the nature and location of alarms. Review and revise graphic layout as required by Owner.

B. Develop CAD drawing files of floor plans and perform the following relative to system graphics:
   1. Delete non-applicable drawing layers and details to arrive at simple floor plans of the building as built.
   2. Convert drawings to a graphic file format compatible with the Owner’s access control and alarm monitoring system.
   3. Load drawing files into the system.
   4. Apply new and predefined icons and other points on each graphic to indicate point and control status.
   5. Link graphic images to reader, monitor and control points.

3.03 TESTING

A. Commission ACAMS in accordance with Section 28 08 00.

END OF SECTION 28 13 00
PART 1 - GENERAL

1.01 SUMMARY

A. General: Furnish engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services required to make a complete working intrusion detection system installation as described in these specifications.

B. Section includes:
   1. Intrusion Detection System, including digital communicator, keypad, and alarm devices.
   2. Door contacts, glass break detectors, motion sensors
   3. Duress alarm stations
   4. Interfaces and connections between intrusion detection subsystems to allow communication with one another

C. Products furnished and installed under another section:
   1. 120V power
   2. Phone line

D. Related sections:
   1. Section 28 00 00 – Basic Security Requirements: for submittal format, warranty, general product requirements, and installation requirements
   2. Section 28 13 00 – ACAMS: for interface requirement to the intrusion detection system
   3. Section 28 08 00 – Security System Acceptance Testing: for testing requirements

1.02 SYSTEM DESCRIPTION

A. Overview
   1. The IDS is utilized for after hours monitoring of the facility.
   2. The IDS integrates with the ACAMS through software to provide bidirectional communication and notification of alarm events.

B. Intrusion Detection System
   1. Provide an IDS control panel with integrated UL listed digital communicator located in the telecommunication room as indicated on project drawings. Panels support up to 8 areas and 128 zones by use of addressable input/output point modules.
   2. Provide LCD command keypads as indicated on project drawings. Keypads allow for system arming and disarming by authorized users.
   3. Provide battery backup of IDS components and power supplies for a minimum of 24 hours in the event of a power failure or emergency.

C. Interface with ACAMS
   1. Provide Ethernet network interface module to allow for software integration with ACAMS.
   2. Configure IDS and ACAMS to allow for bidirectional communication of alarm contacts and motion detectors as shown on the project drawings.

1.03 SUBMITTALS
A. **Product Data:** Submit product information for the intrusion detection systems, including:
   1. IDS control panel
   2. Keypads
   3. Calculations for backup batteries

B. **Shop Drawings:** Submit shop drawings containing the following:
   1. Device placement on floor plans
   2. Point-to-Point Wiring Diagrams: Include wiring, points of connect, and interconnecting devices between the following:
      a. IDS control panel
      b. IDS expansion modules and relays
      c. Keypads
      d. Motion sensors
      e. Alarm contacts
      f. Power supplies
      g. Cable conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)
   3. Schedules: Provide schedules for the IDS control panel that show each alarm zone, applicable area or partition, and a description of the connected device.
   4. Custom mounting details

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**PART 2 - PRODUCTS**

2.01 **IDS CONTROL PANELS**

A. **General**
   1. Integrated UL listed digital communicator with phone line monitor (loop or ground start).
   2. Capable of utilizing multiple telephone numbers, primary and duplicate paths with main and alternate destinations.
   3. Capable of utilizing a dual phone line switcher to monitor 2 phone lines.
   4. Capable of sending daily automatic test and status reports.
   5. Supports supervised expansion and relay output modules.
   6. Permits permanent panel-port connection to automation hubs using GEM-RS232

B. **Manufacturer**
   1. DMP Security Control Panels
      a. DMP XR150 Control Panel
   2. Or equal (no known equal)

2.02 **IDS KEYPADS**

A. **General**
   1. 32-character display
   2. Keys light on entry or key press
   3. Back lighted multi-key touch pad
   4. User controlled brightness and loudness

B. **Provide the ability to display for each detection point:**
   1. Alarm
   2. Trouble
   3. Supervisory
4. Faulted
5. Custom text
6. System wide displays include:
   a. Local system test
   b. Sensor reset
   c. Event log

C. Manufacturer
   1. DMP 7360-W display keypad
   2. Or equal

2.03 MOTION SENSOR

A. Manufacturer
   1. DMP FX-360 Optex PIR
   2. Or Equal

2.04 GLASSBREAK DETECTOR

A. Manufacturer
   1. DMP FG-730 Glassbreak detector
   2. Or Equal

PART 3 - EXECUTION

3.01 INSTALLATION

A. General
   1. Follow manufacturers recommended guidelines for installation.

B. Components
   1. IDS Control Panel
      a. Place control panel and associated expansion boards in SEC (NEMA Type-1 enclosure) with ACAMS equipment in nearest IDF room.
      b. Utilize ACAMS power supplies to power control panel and associated expansion boards. Do not use plug-in transformers.
      c. Provide standoff brackets to mount control boards to perforated panel within enclosure.
      d. Place power supply and associated hardware in same location.
      e. Install supervisory and end of line resistors as required.
      f. Coordinate installation of phone jack in IDS control panel enclosure with telecommunications contractor
   2. Keypads
      a. Coordinate keypad locations with owner.

3.02 PROGRAMMING

A. Prior to the completion of construction, schedule a meeting with the Owner’s IT and Security representatives to determine the following programming criteria:
1. Zone or alarm point descriptions
2. User authority levels to arm/disarm areas or alarm partitions
3. Auto arm/disarm schedules
4. Interface requirement with ACAMS
5. Dispatch response from individual alarm points
6. Password and call list information

B. Document the results of the meeting and perform necessary programming to achieve the Owner’s requests. Program and setup the system such that no additional programming other than entering new access codes is required.

3.03 TESTING

A. Commission the Intrusion Detection System in accordance with Section 28 08 00.

END OF SECTION 28 16 00
PART 1 - GENERAL

1.01 SUMMARY
A. General
1. Provide engineering, labor, materials, apparatus, tools, equipment, transportation, temporary construction, and special or occasional services as required to make a complete working video surveillance system installation, as described in this specification.

2. Section Includes:
   a. Network video recording system
   b. Network video management software
   c. Network video encoder servers
   d. Power supplies

3. Products Furnished and Installed Under another Section:
   a. 120V power
   b. Horizontal fiber optic and UTP cabling for IP cameras

B. Related Sections
1. Consult other Divisions, determine the extent and character of related work and properly coordinate work specified herein with that specified elsewhere to produce a complete and operable system.
2. Section 28 00 00 – Security Basic Requirements: for submittal formats, warranty, general product requirements, and installation requirements.
3. Section 28 08 00 – Security System Acceptance Testing: for testing requirements.
4. Section 28 13 00 – Access Control & Alarm Monitoring System: for interface requirements related to the VSS.

1.02 SYSTEM DESCRIPTION
A. Overview
1. The Owner desires a comprehensive and feature rich IP video surveillance system to monitor the flow of visitors, and staff throughout the building.
2. The VSS consists of video management software, a combination of fixed network cameras, and video encoder servers.
3. The VSS will utilize PoE network cameras within interior and exterior spaces of the building.

B. Video Surveillance System
4. Provide video management software and camera licenses to support the devices shown on the project drawings. Provide rack-mount NVR servers and storage devices to allow for 30 days of storage with recording with 12fps at 1280x720.
5. Provide client video management software licenses for live viewing and monitoring of the cameras. Provide web browser client software license (thin client) to allow for remote viewing on other workstations.

1.03 SUBMITTALS
A. Product Data: Submit product information for components specified herein.
B. Shop Drawings:
   1. Floor Plans: 1/8 inch scale floor and site plans showing the locations of devices and cable routing paths with cable types and quantity called out.
   2. Point-to-Point Diagrams: Include wiring, points of connection and interconnecting devices between the following:
      3. Video surveillance system, monitors, and recording equipment
      4. Devices connected to the system
      5. Conductors (identify conductors on the point-to-point diagrams with the same tag as the installed conductor)
      6. Block Diagram/Riser Diagram: Show the video surveillance system components, conduit, wire types, and cabling interties between termination hardware.
      7. Custom mounting details

1.04 EXTRA MATERIALS
A. Furnish extra materials to the Owner in the original manufacturer’s packaging.
B. Provide spare parts of the following installed devices:
   1. 1 TB hard drive

PART 2 - PRODUCTS
2.01 NETWORK VIDEO RECORDING SOFTWARE
A. General
   1. Complete software-based platform that encompasses recording video, viewing video, reviewing recorded video, and storing video for indefinite periods of time.
   2. The system simultaneously records, displays live video, and plays back video. None of the video operations interfere with each other. Live view and video playback does not interrupt the recording process.

2.02 Manufacturer
   1. S2 Security VRx1000
   2. Or equal

2.03 EXTERIOR CAMERA (270, 360)
A. General
   1. IP based Multisensor camera with infrared capabilities. Each camera to have a minimum of 5MP resolution. Camera is to be mounted on arm on parapet.
B. Manufacturer
   1. Avigilon 15C-H4A-3MH-270/360
      a. Or equal
2.04 INTERIOR CAMERA
A. General
   1. IP based domed camera with infrared capabilities. Camera to have a minimum of 3MP resolution.
B. Manufacturer
   1. Avigilon 3.0C-H4M-D1-IR
      a. Or equal

PART 3 - EXECUTION

3.01 INSTALLATION
A. Network Video Recording Software
   1. Program record rate for network cameras at 12 frames per second at full resolution (1280x720) using H.264 compression format.
   2. Coordinate with Owner’s IT and Security representatives to set the following criteria:
      a. Administrator and operator passwords
      b. Camera and video device naming conventions
      c. Maximum bit rate
      d. Bandwidth throttle
      e. Camera groups and operator views
      f. Mapping features and criteria for a fully interactive graphical display of each floor plan
      g. Alarm events and integration into ACAMS
      h. Interface with POS system in Dining/Serving area
B. Network Video Server & Storage Appliance
   1. Rack mount servers in the city data center as needed. Coordinate with Owner’s IT representative and telecommunications contractor to provide network connectivity.
   2. Install MS Windows Server 2016 and necessary client access licenses.
   3. Install video management software packages.
   4. Configure each array to support the maximum volume of disks in a RAID-6x configuration.
   5. Setup management software to transmit alerts and alarms for disk failure to the ACAMS. This will enable a single point of monitoring all security related alarms.
   6. Connect six (6) patch cords from network switch to each appliance to provide fault tolerance and sufficient switch ports for video throughput.
C. Interior Network HD Cameras
   1. Field determine exact placement of cameras to ensure complete coverage.
   2. Adjust the wide dynamic range, gain control, and noise reduction settings on each camera as required to provide clear and crisp video images.
D. Exterior Network HD Cameras
   1. Provide outdoor housing and mounts for exterior cameras.
   2. Field determine exact placement of cameras to ensure complete coverage.
   3. Coordinate a meeting with Owner’s IT and Security representatives and Division 26 contractor to walk site and confirm actual mounting locations for each CCTV camera prior to installation.
   4. Field determine fixed camera lens size and settings to ensure complete coverage.
3.02 TESTING
   A. Commission the video surveillance system in accordance with Section 28 08 00 – Security System Acceptance Testing.

END OF SECTION 28 23 00
SECTION 31 10 00 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Protecting existing vegetation to remain.
   2. Removing existing vegetation.
   3. Clearing and grubbing.
   4. Stripping and stockpiling topsoil.
   5. Removing above- and below-grade site improvements.
   6. Disconnecting, capping or sealing, and removing site utilities.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

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

1.3 RELATED SECTIONS

A. 31 20 00 EARTH MOVING

B. 31 25 00 EROSION AND SEDIMENTATION

1.4 DEFINITIONS

A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.
C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow.

D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other non-soil materials.

E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.

F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and indicated on Drawings defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.

G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.5 MATERIAL OWNERSHIP

A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.6 INFORMATIONAL SUBMITTALS

A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.

1. Use sufficiently detailed photographs or videotape.
2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

1.7 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.
1.8 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify 811 for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.

E. The following practices are prohibited within protection zones:

1. Storage of construction materials, debris, or excavated material.
2. Parking vehicles or equipment.
3. Foot traffic.
4. Erection of sheds or structures.
5. Impoundment of water.
6. Excavation or other digging unless otherwise indicated.
7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

H. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.
B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #79, Alkyd Anticorrosive Metal Primer or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating with a VOC content of 3.5 lb/gal. or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Wrap a 1-inch blue vinyl tie tape around each tree trunk at 54 inches above the ground.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

A. General: Protect trees and plants remaining on-site as indicated on the drawings.

B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape architect.
3.4 EXISTING UTILITIES

A. Owner will arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing, when requested by Contractor.

1. Verify that utilities have been disconnected and capped before proceeding with site clearing.

B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.
2. Owner will arrange to shut off indicated utilities when requested by Contractor.

C. Locate, identify, and disconnect utilities indicated to be abandoned in place.

D. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than five days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

E. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches below exposed subgrade.
3. Use only hand methods for grubbing within protection zones.
4. Chip removed tree branches and dispose of off-site.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.
B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and non-soil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

1. Limit height of topsoil stockpiles to 72 inches.
2. Do not stockpile topsoil within protection zones.
3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
4. Stockpile surplus topsoil to allow for re-spreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris; coordinate with Texas parks and wildlife for proper disposal locations.

B. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses, and plants.
   2. Excavating and backfilling for buildings and structures.
   3. Drainage course for concrete slabs-on-grade.
   4. Subbase course for concrete pavements.
   5. Subbase course and base course for asphalt paving.
   6. Subsurface drainage backfill for walls and trenches.
   7. Excavating and backfilling trenches for utilities and pits for buried utility structures.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

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

1.3 RELATED SECTIONS:

1. Section 311000 “Site Clearing” for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.

2. Section 312500 “Erosion and Sedimentation Controls”

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

2. Bulk Excavation: Excavation more than 10 feet in width and more than 30 feet in length.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.

2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. or more in volume that exceed a standard penetration resistance of 100 blows/2 inches when tested by a geotechnical testing agency, according to ASTM D 1586.

J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.

L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.

M. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of the following manufactured products required:
   1. Geotextiles.
   2. Controlled low-strength material, including design mixture.
   3. Warning tapes.

1.6 INFORMATIONAL SUBMITTALS

A. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to the geotechnical engineering recommendations.

B. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earth moving operations. Submit before earth moving begins.

1.7 QUALITY ASSURANCE

A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.

B. Preexcavation Conference: Conduct conference at Project site.

1.8 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Utility Locator Service: Notify 811 for area where Project is located before beginning earth moving operations.

C. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, are in place.

D. Do not commence earth moving operations until plant-protection measures are in place.

E. The following practices are prohibited within protection zones:
   1. Storage of construction materials, debris, or excavated material.
   2. Parking vehicles or equipment.
   3. Foot traffic.
   4. Erection of sheds or structures.
   5. Impoundment of water.
   6. Excavation or other digging unless otherwise indicated.
   7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

F. Do not direct vehicle or equipment exhaust towards protection zones.

G. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: Refer to civil plans.

C. Unsatisfactory Soils: Refer to the civil plans
   1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
2.2 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

2. Yellow: Gas, oil, steam, and dangerous materials.
3. Orange: Telephone and other communications.
4. Blue: Water systems.
5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.

B. Protect and maintain erosion and sedimentation controls during earth moving operations.

C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.
3.4 EXCAVATION, GENERAL

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.

   a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

3.5 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

2. Retain first subparagraph below if required.

3. Pile Foundations: Stop excavations 6 to 12 inches above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.

4. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

3.6 EXCAVATION FOR WALKS AND PAVEMENTS

A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit unless otherwise indicated.

1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed subgrade.
2. For pipes and conduit 6 inches or larger in nominal diameter, shape bottom of trench to support bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed subgrade.
4. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

D. Trench Bottoms: Excavate trenches 4 inches deeper than bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe.

1. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

E. Trenches in Tree- and Plant-Protection Zones:
1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with installation of utilities.

3.8 SUBGRADE INSPECTION

A. Notify Architect when excavations have reached required subgrade.

B. If TPWD testing lab determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.

C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.

E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by TPWD testing lab, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by architect.

1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by civil engineer.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.
3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Place backfill on subgrades free of mud, frost, snow, or ice.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Trenches under Footings: Refer to drawings

D. Trenches under Roadways: Refer to drawings.

E. Backfill voids with satisfactory soil while removing shoring and bracing.

F. Place and compact initial backfill free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.

1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utilities testing.

H. Place and compact final backfill of satisfactory soil to final subgrade elevation.
I. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

J. Install warning tape directly above utilities, 12 inches below finished grade, except 6 feet below subgrade under pavements and slabs.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use engineered fill.
   4. Under building slabs, use engineered fill.
   5. Under footings and foundations, use engineered fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to the drawings.
3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
   1. Provide a smooth transition between adjacent existing grades and new grades.
   2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
   1. Turf or Unpaved Areas: Plus or minus 1 inch
   2. Walks: Plus or minus 1 inch
   3. Pavements: Plus or minus 1/2 inch

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

3.17 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.
   3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 300 feet or less of trench length, but no fewer than two tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.18 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.19 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris; coordinate with TPWD for spoils location.

B. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.

1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.
END OF SECTION 312000
SECTION 31 22 16 – FINE GRADING

PART 1 - GENERAL

1.1 SUMMARY:

A. Section includes:
   1. Furnish all labor, material, equipment, related services and supervision necessary for or incidental to fine grading all disturbed areas within the limits of work as shown or indicated on the Drawings and/or as specified.

B. Related Documents
   1. Drawings and General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   2. All other Divisions of the Contract Documents. Refer to each Division’s specifications and drawings for all requirements, including but not limited to the following:
      a. Earthwork – Section 31 20 00.
      b. Topsoil – Section 32 91 19.16
      c. Turf and Grasses – Section 32 92 10.
      d. Plants – Section 32 93 10.

PART 2 - PRODUCTS

2.1 LIMITS OF WORK:

A. The areas to be fine graded are all those disturbed areas within the limits of work as defined on the construction documents.

2.2 SEQUENCE OF WORK:

A. Fine grading will not be attempted until all construction involving heavy equipment and vehicles is complete.

B. After fine grading is accomplished, it shall be the Contractor’s responsibility to protect all fine graded areas from vehicular traffic or other disruptive activities. Damages to the fine graded surfaces will be restored to a satisfactory condition as prescribed herein until the job is completed and accepted by the Architect.

2.3 FINE GRADING OPERATIONS:

A. The following measures will be executed in the accomplishment of fine grading areas to be planted in turfgrass. The Contractor may elect to use additional or supplemental measures to accomplish fine grading.
   1. Fine grading will be executed with any or all of the following or other appropriate machinery: lightweight road grader, tractor box blade, discing machinery, weighted spike harrow, and weighted drags. Bull Dozer blades or front end loader buckets are not acceptable devices for fine grading operations.
   2. It is anticipated that some areas of earth embankment and high traffic areas may become overcompacted and resistant to proper grading. Such areas will be loosened and pulverized with discing machinery and will then be recompacted to normal density before fine grading. The use of a watering truck to moisten dried and hardened areas may be necessary.

2.4 ACCEPTABILITY:
A. The Architect will determine if fine graded areas are acceptable. Areas deemed unacceptable will be corrected and re-graded until they are acceptable.

PART 3 - EXECUTION

3.1 INSPECTION:
A. Examine areas and conditions under which fine grading is to be performed and notify Owner/Architect of conditions detrimental to the proper and timely completion of the work.

3.2 PREPARATION:
A. Provide adequate protective measures of shoring, bracing, piling, planking and cribbing to protect existing adjacent construction.
   1. Protect all reference points, benchmarks and monuments from dislocation or damage.
   2. Replace or repair immediately any points damaged, destroyed, or dislocated.
   3. Sprinkle and dampen all dusty material from the beginning of work to its completion.
   4. Protect and maintain all conduits, drains, inlets, sewers, pipes and wires that are to remain.
   5. Provide, erect and maintain all lights, barricades, warning signs and guards as necessary.
B. The Contractor shall layout all work required and is responsible for all elevations, dimensions and verification of actual conditions. Refer discrepancies to the Architect for interpretation or required modifications.
C. Remove grass, weeds, trees, shrubbery, roots and other vegetation from the areas to be fine graded. Tree roots of protected trees shall not be disturbed. Contractor shall remove vegetation and organic matter by hand labor in tree root zone areas.
D. Coordinate work with Architect in tree root zone areas.

3.3 PUMPING AND DRAINAGE:
A. Keep fine graded areas free from water, ice and snow at all times. Prevent water from interfering with progress or quality of the work.

3.4 RECONDITIONING FINISHED GRADE:
A. Where approved grades are compacted or disturbed by Contractor’s subsequent operations or adverse weather, the finished grades shall be scarified and re-graded as specified herein prior to further construction thereon.

3.5 GRADING:
A. Establish grades by means of grade stakes placed as required. Hold down subgrade to allow depths required for topsoil placement.
B. Fine grade to the elevations required by the drawings.
C. Imported topsoil, if required, will be furnished by the Contractor and installed in landscape planting and lawn turf areas as indicated on the landscape plan. Native topsoil will be placed in the areas from which they were salvaged from as per the drawings.
D. Finish grade to the elevations required by the drawings and for proper drainage. At intermediate points, for which finish grades are not indicated, the finish grade shall be of
uniform level of slope between points for which elevations are given. Round any abrupt changes in elevation.
E. Laser grade athletic fields to be precision graded using laser leveling equipment to achieve a tolerance of 1/10 of an inch.

3.6 ADJUSTMENTS AND CLEANING:

A. Settlement or washing that occurs in fine graded areas prior to acceptance of work shall be repaired and grades re-established to the required elevations and slopes.
B. Cleanup all debris caused by the work of this section, keep the site clean and neat at all times.

END OF SECTION 31 22 16
SECTION 31 25 00 – EROSION AND SEDIMENTATION CONTROLS

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:
   1. Temporary and permanent erosion control systems.
   2. Slope protection systems.

1.02 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including "Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.

1.03 RELATED SECTIONS

A. 31 20 00 EARTH MOVING
B. 31 10 00 SITE CLEARING

1.04 PROJECT CONDITIONS OR SITE CONDITIONS

A. Environmental Requirements: Protect adjacent properties and water resources from erosion and sediment damage throughout Work.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Quick Growing Grasses: Wheat, rye, or oats.
B. Straw Bales: Free of weed seed.
C. Mulch sock
D. Fencing for Siltation Control: Indicated on Drawings.

E. Erosion Control Blankets and/or Erosion Control Geotextiles.

F. Bale Stakes:
   1. Minimum 4 feet length.
   2. 2 No. 4 steel reinforcing bars or,
   3. 2 steel pickets or,
   4. 2 - 2x2 inch hardwood stakes driven 18 inches to 24 inches into ground.

G. Temporary Mulches: Loose straw, netting, wood cellulose, or agricultural silage free of seed.

H. Metal Fence Stakes: Minimum 8 foot length.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verification of Conditions: Verify that field measurements, surfaces, substrates and conditions are as required, and ready to receive Work.

B. Report in writing to Contracting Officer prevailing conditions that will adversely affect satisfactory execution of the Work of this Section. Do not proceed with Work until unsatisfactory conditions have been corrected.

C. By beginning Work, Contractor accepts conditions and assumes responsibility for correcting unsuitable conditions encountered at no additional cost to U.S. Postal Service.

3.02 PREPARATION

A. Review Stormwater Pollution Prevention Plan SWPPP.

B. Notify Contracting Officer of deficiencies or changes in Stormwater Pollution Prevention Plan SWp3 required by current site conditions. Revisions of plan will be made as determined by Contracting Officer.

3.03 EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION
A. Contracting Officer may direct Contractor to limit surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations and may direct Contractor to provide immediate permanent or temporary pollution control measures.

B. Provide permanent erosion control measures at earliest practical time to minimize requirement for temporary erosion controls. Permanently seed and mulch cut slopes as excavation proceeds.

C. Maintain temporary erosion control systems installed by Contractor as directed by Contracting Officer to control siltation at all times throughout Work. Provide maintenance or additional Work directed by Contracting Officer within 48 hours of notification by Contracting Officer.

D. Apply soil stabilization as specified in Section 31 32 00 or seed slopes that may be easily eroded with wheat, rye or oat grasses.

END OF SECTION 31 25 00
SECTION 31 31 16 – TERMITE CONTROL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
B. General Contractor shall coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work that depend on each other for proper installation, connection, and operation.

1.02 SUMMARY
A. Section Includes: Furnish and install a chemical barrier to afford the structure protection from termites and other common ground insects
   1. Soil treatment for termite control.
B. Related Sections include the following:
   1. Division 03, Section "Cast-In-Place Concrete"
   2. Division 06, Section "Rough Carpentry", for wood preservative treatment by pressure process.
   3. Division 07, Section "Vapor Barrier".

1.03 QUALITY ASSURANCE
A. Comply with all applicable regulatory and environmental requirements.
B. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.
   1. Any chemicals toxic to animals and plant life should be applied with caution by an experienced person who is licensed in accordance with the regulatory agency of the State.
C. Regulatory Requirements: Formulate and apply termiticides and termicide devices according to the EPA-Registered Label.
D. Preinstallation Conference: Conduct conference at Project site.

1.04 SUBMITTALS
A. Action Submittals: Product Data: For each type of product.
   1. Include construction details, material descriptions, dimensions of individual components, and profiles for termite control products.
   2. Include the EPA-Registered Label for termiticide products.
B. Informational Submittals:
   1. Qualification Data: For qualified Installer.
   2. Product Certificates: For each type of termite control product.
   3. Sample Warranties.
C. Closeout Submittals: Soil Treatment Application Report: After application of termiticide is completed, submit report for Owner's records and inclusion in O&M Manuals. Include the following:
   1. Date and time of application.
   2. Moisture content of soil before application.
   3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

1.05 PROJECT CONDITIONS
A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.
B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.06 WARRANTY
A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that project has been registered with Manufacturer to meet the required Warranty criteria, provide termite control work for the duration of the Warranty, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites, including Formosan termites (Coptotermes formosanus). If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.
1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS
2.01 SOIL TREATMENT
A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.
1. Products: Subject to compliance with requirements, provide one of the following:
   a. BASF Corporation, Agricultural Products; Termidor.
   b. Bayer Environmental Science; Premise.
2. Pest Control Contractors: Subject to compliance with requirements, acceptable applicators include but are not necessarily limited to:
   a. Terminix
   b. Orkin
   c. Myers
   d. Metrogard
3. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.
B. Materials shall be used, provided:
1. They are determined to meet five (5) year test conducted by the U.S. Forest Service, or the U.S. Department of Agriculture.
2. Evidence is provided indicating any toxic effects to humans, plants or animal life.
3. Allowed by governing laws and/or ordinances.

PART 3 - EXECUTION
3.01 APPLICATION, GENERAL
A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.02 APPLYING SOIL TREATMENT
A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for moisture content of soil per termicide label requirements, interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.
B. Proceed with application only after unsatisfactory conditions have been corrected.
C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termicides may be applied before placing compacted fill under slabs if recommended in writing by termicide manufacturer.
   1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.
D. Application: Mix soil treatment termicide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termicide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.
   1. Slabs-on-Grade and Basement Slabs: Underground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
   2. Foundations: Adjacent soil, including soil along the entire inside perimeter of foundation walls; along both sides of interior partition walls; around plumbing pipes and electric conduit penetrating the slab; around interior column footers, piers, and chimney bases; and along the entire outside perimeter, from grade to bottom of footing. Avoid soil washout around footings.
   3. Masonry: Treat voids at masonry that rest on footings below grade.
   4. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.
E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.
F. Post warning signs in areas of application.
G. Protect termicide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.
H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 31 31 16
SECTION 32 12 16 – ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.

1.2 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including "Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department" apply to this Section.

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

1.3 RELATED SECTIONS

A. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

B. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.  Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

   a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
   b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.
1. Include technical data and tested physical and performance properties.
2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For manufacturer.
B. Material Certificates: For each paving material.
C. Material Test Reports: For each paving material, by a qualified testing agency.
D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.
B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of TXDOT for asphalt paving work.
   1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.8 FIELD CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
   1. Prime Coat: Minimum surface temperature of 60 deg F
   2. Tack Coat: Minimum surface temperature of 60 deg F
   4. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

D. Mineral Filler: ASTM D 242/D 242M or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320, PG 64-22, PG 58-28, OR PG 70-22

B. Asphalt Cement: ASTM D 3381 for viscosity-graded material, or ASTM D 946 for penetration graded material.

C. Cutback Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70

D. Emulsified Asphalt Prime Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

E. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Water: Potable.

2.3 AUXILIARY MATERIALS

A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

C. Sand: ASTM D 1073, Grade No. 2 or No. 3.

D. Joint Sealant: ASTM D 6690, Type I hot-applied, single-component, polymer-modified bituminous sealant.

2.4 MIXES

A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph.

2. Revise the minimum weight or type of vehicle in first subparagraph below if required.

3. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.

4. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

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

3.2 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.

1. Mix herbicide with prime coat if formulated by manufacturer for that purpose.
C. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
   1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
   2. Protect primed substrate from damage until ready to receive paving.

D. Emulsified Asphalt Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.10 to 0.30 gal./sq. yd. per inch depth, Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
   1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
   2. Protect primed substrate from damage until ready to receive paving.

E. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
   1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
   2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 PLACING HOT-MIX ASPHALT

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
   1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
   2. Place hot-mix asphalt surface course in single lift.
   3. Spread mix at a minimum temperature of 250 deg F
   4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
   5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
   1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
2. Complete a section of asphalt base course before placing asphalt surface course.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches
3. Offset transverse joints, in successive courses, a minimum of 24 inches
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints as shown on Drawings.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.
2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch
2. Surface Course: Plus 1/4 inch, no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: **1/4 inch**
2. Surface Course: **1/8 inch**
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

3.7 FIELD QUALITY CONTROL

A. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

B. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

C. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.

D. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
   
a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than three cores taken.
   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.8 WASTE HANDLING

A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION 321216
PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Driveways.
   2. Roadways.
   3. Parking lots.
   4. Curbs and gutters.
   5. Walks.

1.2 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including "Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department" apply to this Section.

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

1.3 RELATED SECTIONS:

1. Section 321373 "Concrete Paving Joint Sealants" for joint sealants in expansion and contraction joints within concrete paving and in joints between concrete paving and asphalt paving or adjacent construction.

1.4 DEFINITIONS

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

1.5 ACTION SUBMITTALS

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

B. Other Action Submittals:
1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer of detectable warnings, ready-mix concrete manufacturer and testing agency.

B. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Steel reinforcement and reinforcement accessories.
   3. Fiber reinforcement.
   4. Admixtures.
   5. Curing compounds.
   7. Bonding agent or epoxy adhesive.
   8. Joint fillers.

C. Material Test Reports: For each of the following:
   1. Aggregates.

D. Field quality-control reports.

1.7 QUALITY ASSURANCE

A. Detectable Warning Installer Qualifications: An employer of workers trained and approved by manufacturer of stamped concrete paving systems.

B. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
   1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

C. Testing Agency Qualifications: Qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
   1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
D. Concrete Testing Service: Engage a qualified testing agency to perform material evaluation tests and to design concrete mixtures.

E. ACI Publications: Comply with ACI 301 unless otherwise indicated.

F. Preinstallation Conference: Conduct conference at Project site.
   1. Review methods and procedures related to concrete paving, including but not limited to, the following:
      a. Concrete mixture design.
      b. Quality control of concrete materials and concrete paving construction practices.
   2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:
      a. Contractor's superintendent.
      b. Independent testing agency responsible for concrete design mixtures.
      c. Ready-mix concrete manufacturer.
      d. Concrete paving subcontractor.
      e. Manufacturer's representative of stamped concrete paving system used for detectable warnings.

1.8 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F, for oil-based materials 55 deg F for water-based materials, and not exceeding 95 deg F

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.

   1. Use flexible or uniformly curved forms for curves with a radius of 100 feet or less.

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

A. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 25 percent.

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

C. Plain-Steel Wire: ASTM A 82/A 82M.

D. Deformed-Steel Wire: ASTM A 496/A 496M.

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

F. Tie Bars: ASTM A 615/A 615M, Grade 60 deformed.

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

1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.


2.3 CONCRETE MATERIALS

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

1. Portland Cement: ASTM C 150, portland cement
   a. Fly Ash: ASTM C 618,
   b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.


Normal-Weight Aggregates: ASTM C 33, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.


B. Water: Potable and complying with ASTM C 94/C 94M.

D. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

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

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry or cotton mats.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

F. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.5 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.

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

C. Epoxy Bonding Adhesive: ASTM C 881/C 881M, two-component epoxy resin capable of humid curing and bonding to damp surfaces; of class suitable for application temperature, of grade complying with requirements, and of the following types:

1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
D. Chemical Surface Retarder: Water-soluble, liquid, set retarder with color dye, for horizontal concrete surface application, capable of temporarily delaying final hardening of concrete to a depth of 1/8 to 1/4 inch.

E. Pigmented Mineral Dry-Shake Hardener: Factory-packaged, dry combination of portland cement, graded quartz aggregate, color pigments, and plasticizing admixture. Use color pigments that are finely ground, nonfading mineral oxides interground with cement.

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

2.6 DETECTABLE WARNING MATERIALS

A. Detectable Warning Stamp: Semirigid polyurethane mats with formed underside capable of imprinting detectable warning pattern on plastic concrete; perforated with a vent hole at each dome.

1. Manufacturers: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Advanced Surfaces Inc.
   b. Matcrete Precision Stamped Concrete Tools.
   c. Southern Color N.A., Inc.
   d. Stampcrete International Ltd.
   e. Superior Decorative by Dayton Superior.

2. Size of Stamp: One piece matching detectable warning area shown on Drawings

B. Liquid Release Agent: Manufacturer’s standard, clear, evaporating formulation designed to facilitate release of stamp mats.

1. Products: Subject to compliance with requirements available products that may be incorporated into the Work include, but are not limited to, the following:
   b. Matcrete Precision Stamped Concrete Tools; Liquid Release Agent.
   d. Stampcrete International Ltd.; Stampcrete Liquid Release.
   e. Superior Decorative by Dayton Superior; Pro Liquid Release.

2.7 WHEEL STOPS

A. Wheel Stops: Precast, air-entrained concrete, 2500-psi minimum compressive strength, 4-1/2 inches high by 9 inches wide by 72 inches long. Provide chamfered corners and drainage slots on underside and holes for anchoring to substrate.
1. Dowels: Galvanized steel, 3/4 inch in diameter, 10-inch minimum length.

2.8 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that meet or exceed requirements.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): As shown on drawings.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: Refer to geotechnical engineering report.

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

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

1. Use water-reducing admixture, high-range, water-reducing admixture, high-range, water-reducing and retarding admixture, or plasticizing and retarding admixture in concrete as required for placement and workability.
2. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:

1. Fly Ash or Pozzolan: 25 percent.
2. Ground Granulated Blast-Furnace Slag: 50 percent.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph
   2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons
   3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch according to requirements in Section 312000 "Earth Moving."

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

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 STEEL REINFORCEMENT

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

B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.

C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
3.5 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
2. Provide tie bars at sides of paving strips where indicated.
3. Butt Joints: Use epoxy bonding adhesive at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches into concrete.
5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
2. Extend joint fillers full width and depth of joint.
3. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
4. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
6. During concrete placement, protect top edge of joint filler with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes.
a. Tolerance: Ensure that grooved joints are within 3 inches either way from centers of dowels.

2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.

   a. Tolerance: Ensure that sawed joints are within 3 inches either way from centers of dowels.

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

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

3.6 CONCRETE PLACEMENT

A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.

B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.

F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

G. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

   1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
H. Screed paving surface with a straightedge and strike off.

I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

J. Curbs and Gutters: Use design mixture for automatic machine placement. Produce curbs and gutters to required cross section, lines, grades, finish, and jointing.

K. Slip-Form Paving: Use design mixture for automatic machine placement. Produce paving to required thickness, lines, grades, finish, and jointing.

1. Compact subbase and prepare subgrade of sufficient width to prevent displacement of slip-form paving machine during operations.

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

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

M. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor’s option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.7 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces
to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. **Burlap Finish:** Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.

2. **Medium-to-Fine-Textured Broom Finish:** Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

3. **Medium-to-Coarse-Textured Broom Finish:** Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

### 3.8 CONCRETE PROTECTION AND CURING

A. **General:** Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. **Comply with ACI 306.1 for cold-weather protection.**

C. **Evaporation Retarder:** Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer’s written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. **Begin curing after finishing concrete but not before free water has disappeared from concrete surface.**

E. **Curing Methods:** Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these as follows:

1. **Moisture Curing:** Keep surfaces continuously moist for not less than seven days with the following materials:
   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. **Moisture-Retaining-Cover Curing:** Cover concrete surfaces with moisture-retaining cover, placed in widest practicable width, with sides and ends lapped at least 12 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears occurring during installation or curing period using cover material and waterproof tape.

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

3.9 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 3/4 inch
2. Thickness: Plus 3/8 inch, minus 1/4 inch
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/2 inch
4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches of tie bar.
5. Lateral Alignment and Spacing of Dowels: 1 inch
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches of dowel.
8. Joint Spacing: 3 inches.

3.10 WHEEL STOPS

A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.

B. Securely attach wheel stops to paving with not less than two steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 FIELD QUALITY CONTROL

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

1. Testing Frequency: Obtain at least one composite sample for each 5000 sq. ft. or fraction thereof of each concrete mixture placed each day.
   a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.

4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when it is 80 deg F and above, and one test for each composite sample.

5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test one specimen at seven days and two specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.

   B. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

   C. Test results shall be reported in writing to Architect, Civil Engineer, Owner, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

   D. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

   E. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

   F. Concrete paving will be considered defective if it does not pass tests and inspections.

   G. Additional testing and inspecting, at Contractor’s expense, will be performed to determine compliance of replaced or additional work with specified requirements.

   H. Prepare test and inspection reports.

3.12 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
B. Drill test cores, where directed by Civil Engineer, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.

C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313
PART 1  GENERAL

1.1  SUMMARY

A.  Section Includes:
   1. Landscape concrete paving.

B.  Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 03 30 53 - Landscape Cast-in-Place Concrete.
   3. Section 07 92 05 - Landscape Joint Sealers.

1.2  REFERENCES


1.3  SUBMITTALS

A.  Submittals for Review:
   1. Product Data: Indicate products and accessories proposed for use.

1.4  QUALITY ASSURANCE

A.  Installer Qualifications: Minimum 3 years experience in work of this Section.

B.  Mockups:
   1. Provide mockup of concrete paving color and finish, minimum 10 x 10 feet.
   2. Show:
      a. Paving color.
      b. Each Finish.
      c. Control and expansion joints.
   3. Locate where directed.
   4. Approved mockups may remain as part of the Work.

PART 2  PRODUCTS

2.1  MATERIALS

A.  Concrete: As specified in Section 03 30 53 except:
   1. Formwork:
      b. Wood forms: Good grade lumber, sound and free of warp, minimum 2 inch nominal thickness except where extremely short radii of curves require thinner forms.
   2. Dowels: Plain round bar dowels, conforming to reinforcing steel requirements.

2.2  ACCESSORIES

A.  Joint Filler: ASTM D4819, Type II, closed cell polyethylene, non-staining, chemical resistant, ultraviolet stable, non-absorbent, with removable strip providing recess for joint sealer.
B. Joint Sealer: Specified in Section 07 92 05.

2.3 MIXES
   A. Mix concrete in accordance with Section 03 30 53.

PART 3 EXECUTION

3.1 CONSTRUCTION OF FORMS
   A. Construct formwork in accordance with Section 03 30 53.
   B. Set forms accurately to required grades and alignment.
   C. Brace forms to withstand loads applied during concrete placement.
   D. Install flexible or curved forms of wood or metal for curves with radius of 300 feet or less.
   E. Align straight and curved sections at true tangent points without broken curves.
   F. Form curves uniform and smooth, to radius indicated.
   G. Leave forms in place for minimum 12 hours after completion of finishing operation.
   H. Provide expansion joints where paving abuts other construction, and at maximum 30 feet on center unless otherwise indicated on Drawings.
      1. Shape joint filler to concrete cross section and fasten in place.
      2. Provide holes for dowel bars maximum 1/8 inch larger than bar diameter.
      3. Provide 24 inch long No. 4 reinforcing bars or smooth steel dowels spaced maximum 24 inches on center, centered on expansion joint. Wrap one end of bars or dowels with two layers PVC tape.

3.2 PLACING REINFORCING
   A. Install reinforcement in accordance with Section 03 30 53.
   B. Place reinforcing in middle third of flatwork.
   C. Stop alternate bars of reinforcing steel at control joints.
   D. Provide dowels at maximum 12 inches on center at expansion joints. Wrap one end of dowel in building paper or felt. Stop reinforcement on both sides of joint.

3.3 PLACING CONCRETE
   A. Place concrete in accordance with Section 03 30 53.
   B. Place concrete continuously between predetermined expansion and control joints. Do not interrupt successive placement such that cold joints occur.
   C. Shape curbs and gutters to cross section indicated on Drawings.
D. Strike off flatwork with screed, then float to uniform surface.

E. Tool expansion joint edges and other exposed edges to smooth, dense surface with 1/8 inch radius.

F. Seal expansion joints as specified in Section 07 92 05.

G. Provide control joints at maximum 10 feet on center unless otherwise indicated on Drawings. Saw joints within 24 hours after concrete placement, to width of single blade x 1/4 of slab depth.

H. Installation Tolerances: Surfaces true to plane, in longitudinal direction to required grade, within plus or minus 1/4 inch in 10 feet, noncumulative.

3.4 FINISHING

A. Broom Finish:
   1. Steel trowel and medium broom finish surfaces with striations running perpendicular to short dimension.
   2. Match approved mockup.

END OF SECTION 32 13 14
**SECTION 32 13 73 – CONCRETE PAVING JOINT SEALANTS**

**PART 1 - GENERAL**

1.1 **SUMMARY**

A. Section Includes:

   1. Cold-applied joint sealants.
   2. Hot-applied joint sealants.

1.2 **RELATED DOCUMENTS**

A. Drawings and general provisions of the Contract, including "Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department" apply to this Section.

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

1.3 **RELATED SECTIONS:**

   1. Section 321313 "Concrete Paving" for constructing joints in concrete pavement.

1.4 **PRECONSTRUCTION TESTING**

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, Samples of materials that will contact or affect joint sealants.

   1. Use ASTM C 1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
   2. Submit no fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
   3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
   4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
   5. Testing will not be required if joint-sealant manufacturers submit joint-preparation data that are based on previous testing, not older than 24 months, of sealant products for
compatibility with and adhesion to joint substrates and other materials matching those submitted.

1.5 ACTION SUBMITTALS

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

B. Pavement-Joint-Sealant Schedule: Include the following information:
   1. Joint-sealant application, joint location, and designation.
   2. Joint-sealant manufacturer and product name.

1.6 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of joint sealant and accessory, from manufacturer.

B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.

C. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
   1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
   2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

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. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

C. Product Testing: Test joint sealants using a qualified testing agency.
   1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

D. Preinstallation Conference: Conduct conference at Project site.
1.8 PROJECT CONDITIONS

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

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

B. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 COLD-APPLIED JOINT SEALANTS

A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.

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

   a. Crafco Inc., an ERGON company; RoadSaver Silicone.
   b. Dow Corning Corporation; 888.
   c. Pecora Corporation; 301 NS.

B. Single-Component, Self-Leveling, Silicone Joint Sealant for Concrete: ASTM D 5893, Type SL.

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

   a. Crafco Inc., an ERGON company; RoadSaver Silicone SL.
   b. Dow Corning Corporation; 890-SL.
   c. Pecora Corporation; 300 SL.

C. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
1. **Products:** Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

   a. **Pecora Corporation:** Urexpan NR-200.

2.3 **HOT-APPLIED JOINT SEALANTS**


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

   a. **Crafco Inc.,** an ERGON company; Superseal 444/777.


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

   a. **Meadows, W. R., Inc.;**
   b. **Right Pointe:** D-3405 Hot Applied Sealant.

2.4 **JOINT-SEALANT BACKER MATERIALS**

A. General: Provide joint-sealant backer materials that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.

B. Round Backer Rods for Cold- and Hot-Applied Joint Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

C. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

D. Backer Strips for Cold- and Hot-Applied Joint Sealants: ASTM D 5249; Type 2; of thickness and width required to control joint-sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.

2.5 **PRIMERS**

A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.

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

3.2 PREPARATION

A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.

B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.

B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.

   1. Do not leave gaps between ends of joint-sealant backings.
   2. Do not stretch, twist, puncture, or tear joint-sealant backings.
   3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.

D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:

   1. Place joint sealants so they directly contact and fully wet joint substrates.
   2. Completely fill recesses in each joint configuration.
3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.

E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:

1. Remove excess joint sealant from surfaces adjacent to joints.
2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.

F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

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

3.5 PROTECTION

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

3.6 PAVEMENT-JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Joints within cement concrete pavement.

1. Joint Location:
   c. Other joints as indicated.

3. Urethane Joint Sealant for Concrete: Multicomponent, pourable, traffic-grade.
5. Joint-Sealant Color: As selected by Architect from manufacturer's full range.
B. Joint-Sealant Application: Joints between cement concrete and asphalt pavement

1. Joint Location:
   a. Joints between concrete and asphalt pavement.
   b. Joints between concrete curbs and asphalt pavement.
   c. Other joints as indicated.

3. Joint-Sealant Color: As selected by Architect from manufacturer’s full range.

END OF SECTION 32 13 73
PART 1  GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Stone pavers on mortar setting bed.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.
   2. Section 07 92 05 - Landscape Joint Sealers.

1.2 REFERENCES


1.3 SUBMITTALS

A. Submittals for Review:
   1. Samples:
      a. Stone: 12 x 12 inch samples showing colors and surface textures.
      b. Grout: 1/2 x 1/2 x 3 inch long samples showing available colors.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Minimum 2 years experience in work of this Section.

B. Obtain each stone from a single quarry and from the same area within the quarry.

C. Mockups:
   1. Size: Minimum 4 x 8 feet.
   2. Show: Paver sizes, colors and surface textures, maximum color range, and paver pattern.
   3. Locate where directed.
   4. Approved mockups may remain as part of the Work.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store stone off ground; prevent contact with materials that could cause staining or damage.

1.6 PROJECT CONDITIONS

A. Environmental Requirements: Do not install pavers at temperatures below 50 degrees F, during precipitation, or when such conditions are forecast within 48 hours after installation.

B. At end of working day and during rainy weather, cover work exposed to weather with waterproof coverings, securely anchored.
PART 2 PRODUCTS

2.1 MATERIALS
A. Stone Pavers: Refer to Materials Legend.

2.2 ACCESSORIES
A. Setting and Grouting Materials: Laticrete International (www.laticrete.com) or approved substitute.
   1. Setting mortar: Laticrete 3701 Fortified Mortar.
   2. Bond coat: 254 Platinum.
   3. Grout: Permacolor Select; color to be selected from manufacturer’s full color range.
B. Joint Sealers and Accessories: Specified in Section 07 92 05.
C. Cleaner: Type recommended by stone supplier.

PART 3 EXECUTION

3.1 INSTALLATION
A. Install pavers in accordance with setting and grouting manufacturer’s instructions and TCNA Handbook.
   1. Apply bond coat to concrete substrate.
   2. Apply setting mortar.
   3. Just prior to installing stone, apply bond coat to back of stone.
B. Support pavers over full bearing surface.
C. Place pavers in pattern indicated from straight reference line. Maintain 3/8 inch joints between pavers and abutting vertical surfaces and protrusions.
D. Fill joints with grout. Pack and work into voids. Tool joints to flush profile.
E. Fill expansion joints with joint sealer as specified in Section 07 92 05.
F. Allowable Tolerances: Surfaces true to level or indicated slopes with plus or minus 1/4 inch in 10 feet tolerance.

3.2 CLEANING
A. Protect adjacent and underlying surfaces and plant materials.
B. Apply cleaner in accordance with manufacturer's instructions.
C. Thoroughly rinse surfaces with clean water after completion of cleaning; remove all traces of cleaning solution.

END OF SECTION 32 14 40
PART 1  GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reused on-site materials.
   2. Lava rock.
   5. Herbicide.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 REFERENCES

A. ASTM International (ASTM):
   3. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.3 SUBMITTALS

A. Submittals for Review:
   1. Samples:
      a. 1 pint of each proposed aggregate illustrating color, size, and gradation.
      b. 12 x 12 inch filter fabric samples.

1.4 QUALITY ASSURANCE

A. Furnish each aggregate from single source throughout Work.

B. Perform sieve analysis on proposed decomposed granite in accordance with ASTM C136.

C. Obtain stabilizer manufacturer’s approval of decomposed granite aggregate sieve analysis prior to beginning installation.

D. Mockups:
   1. Provide mockups showing each aggregate surfacing size and color range, surface texture, and overall workmanship.
   2. Size: Minimum 10 x 10 feet.
   3. Locate where directed.
   4. Approved mockups may remain as part of the Work.

1.5 PROJECT CONDITIONS

A. Do not place aggregate on soft, muddy, or frozen surfaces.
B. Do not install aggregate during precipitation or at temperatures below 40 degrees F.

PART 2 PRODUCTS

2.1 MATERIALS

A. Aggregate G-1: Material harvested on site, crushed and sieved to following gradation:

<table>
<thead>
<tr>
<th>US Sieve No.</th>
<th>Percent Passing by Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/8 inch</td>
<td>100</td>
</tr>
<tr>
<td>No. 4</td>
<td>90 to 100</td>
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<tr>
<td>No. 8</td>
<td>75 to 80</td>
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<tr>
<td>No. 16</td>
<td>55 to 65</td>
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<tr>
<td>No. 30</td>
<td>40 to 50</td>
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<td>25 to 35</td>
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<tr>
<td>No. 100</td>
<td>15 to 20</td>
</tr>
<tr>
<td>No. 200</td>
<td>10 to 15</td>
</tr>
</tbody>
</table>

B. Aggregate G-2: Material harvested on site, crushed and sieved to size indicated in Materials Legend.

C. Aggregate G-3: Refer to Materials Legend.

2.2 ACCESSORIES

A. Stabilizer: Stabilizer by Stabilizer Solutions, Inc. (www.stabilizersolutions.com) or approved substitute.

B. Filter Fabric: Geosynthetic fabric manufactured specifically for use under paving.

C. Herbicide: Pre-emergent, non-selective type.

2.3 MIXES

A. Mix stabilizer with decomposed granite aggregate in accordance with manufacturer’s instructions.

PART 3 EXECUTION

3.1 PREPARATION

A. Correct irregularities in subgrade gradient and elevation by scarifying and reshaping.

B. Compact subgrade to minimum 85 percent of ASTM D698 standard Proctor maximum dry density at or near optimum moisture content.

C. Apply herbicide in accordance with manufacturer’s instructions. Allow vegetation to die before proceeding.
3.2 INSTALLATION

A. Place filter fabric over substrate; install in accordance with manufacturer's instructions.
B. Spread aggregate over subgrade to minimum compacted or uncompacted thickness indicated.
C. Level and contour surfaces to elevations and gradients indicated.
D. Water aggregate to full depth without flooding and runoff.
E. When G-1 Aggregate is capable of supporting compaction equipment without damage, roller compact to minimum 95 percent of ASTM D4254 relative density at or near optimum moisture content.
F. Use mechanical tamping equipment in areas inaccessible to compaction equipment.
G. Do not compact G-2 or G-3 Aggregates.
H. Where aggregate surfacing abuts other paving types, align top surface of aggregate to within 1/4 inch of adjacent surfaces after compaction.
I. Final surface to be firm, stable, free of cracks, and slip-resistant.
J. After compaction, apply herbicide in accordance with manufacturer’s instructions.
K. Tolerances:
   1. G-1 Aggregate:
      a. Maximum variation from flat surface: ½ inch in 10 feet.
      b. Maximum variation from thickness: ½ inch.
      c. Maximum variation from elevation: ½ inch.
   2. G-2 and G-3 Aggregates:
      a. Maximum variation from thickness: ½ inch.
      b. Maximum variation from elevation: ½ inch.

3.3 FIELD QUALITY CONTROL

A. Testing and Inspection Services:
   1. After compaction of subbase for decomposed granite surfacing perform field in-place density tests per ASTM D6938, one test for each 2500 square feet.
   2. Upon completion of decomposed granite surfacing perform field in-place density tests per ASTM D6938, one test for each 2500 square feet.

END OF SECTION 32 15 00
SECTION 32 17 13 - PARKING BUMPERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete parking bumpers.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:
   1. Product Data: Provide unit configuration and dimensions.

PART 2 PRODUCTS

2.1 MATERIALS

A. Concrete Mix: Minimum 3500 PSI, 28 day strength, air entrained to 5 to 7 percent.

2.2 ACCESSORIES

A. Reinforcing Bars: No. 3 deformed steel.

B. Dowels: Steel, ½ inch diameter x 24 inches long, pointed tip.

2.3 FABRICATION

A. Use rigid molds, constructed to maintain precast units uniform in shape, size and finish. Maintain consistent quality during manufacture.

B. Embed two longitudinal reinforcing bars.

C. Cure units to develop concrete quality, and to minimize appearance blemishes including non uniformity, staining, and surface cracking.

D. Minor patching in plant is acceptable, providing appearance of units is not impaired.

E. Nominal Size: 6 inches high x 6 inches deep x 6 feet long.

F. Provide two vertical fastening holes per unit.

G. Profile: Rectangular cross section with rounded or canted top, square ends.

H. Finish: Manufacturer's standard.
PART 3 EXECUTION

3.1 INSTALLATION

A. Set units in place without damage to shape or finish.

B. Align adjacent units.

C. Secure to paving with two dowels per unit.

END OF SECTION 32 17 13
SECTION 32 17 23 – PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY
A. Section includes painted markings applied to asphalt and concrete pavement.

1.2 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including “Uniform General Conditions for State of Texas Construction Contracts Including Supplementary General Conditions for Projects Administered by the Texas Parks and Wildlife Department” apply to this Section.
B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.3 PREINSTALLATION MEETINGS
A. Preinstallation Conference: Conduct conference at Project site
   1. Review methods and procedures related to marking pavement including, but not limited to, the following:
      a. Pavement aging period before application of pavement markings.
      b. Review requirements for protecting pavement markings, including restriction of traffic during installation period.

1.4 ACTION SUBMITTALS
A. Product Data: For each type of product.
   1. Include technical data and tested physical and performance properties.

1.5 QUALITY ASSURANCE
A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the TXDOT construction specifications for pavement-marking work.
1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F for alkyd materials, 55 deg F for water-based materials, and not exceeding 95 deg F.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Benjamin Moore & Co.
   2. PPG Industries.

2.2 PAVEMENT-MARKING PAINT

A. Pavement-Marking Paint: Alkyd-resin type, lead and chromate free, ready mixed, complying with AASHTO M 248; colors complying with FS TT-P-1952.
   1. Color: As indicated

B. Pavement-Marking Paint: MPI #32, alkyd traffic-marking paint.
   1. Color: As indicated

C. Pavement-Marking Paint: Latex, waterborne emulsion, lead and chromate free, ready mixed, complying with FS TT-P-1952, Type II, with drying time of less than 45 minutes.
   1. Color: As indicated

D. Pavement-Marking Paint: MPI #97, latex traffic-marking paint.
   1. Color: As indicated

E. Glass Beads: AASHTO M 247, Type 1.
   1. Roundness: Minimum 80 percent true spheres by weight.
F. VOC Content: Pavement markings used on building interior shall have a VOC content of 150 g/L or less.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that pavement is dry and in suitable condition to begin pavement marking according to manufacturer’s written instructions.

B. Proceed with pavement marking only after unsatisfactory conditions have been corrected.

3.2 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for a minimum of 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

   1. Apply graphic symbols and lettering with paint-resistant, die-cut stencils, firmly secured to pavement. Mask an extended area beyond edges of each stencil to prevent paint application beyond the stencil. Apply paint so that it cannot run beneath the stencil.

   2. Broadcast glass beads uniformly into wet markings at a rate of 6 lb/gal.

3.3 PROTECTING AND CLEANING

A. Protect pavement markings from damage and wear during remainder of construction period.

B. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 321723
PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electric operators for swing gates.
   2. Controls.

1.2 SYSTEM DESCRIPTION

A. Control System:
   1. Entrance:
      a. Opening initiated by keypad, card reader, or remote control; closing initiated by buried loop vehicle detector.
      b. Timer to allow gate to remain opened remotely during day and manually closed at night.
   2. Exit: Opening and closing initiated by buried loop vehicle detectors.

1.3 SUBMITTALS

A. Submittals for Review:
   2. Product Data: Manufacturer’s descriptive data and product attributes.

B. Closeout Submittals:
   1. Operation and Maintenance Data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Firm specializing in work of this Section, with minimum 2 years’ experience.

1.5 WARRANTY

A. Provide manufacturer’s 5 year warranty against material and manufacturing defects.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Contract Documents are based on products by Liftmaster. www.liftmaster.com

B. Substitutions: Refer to Division 01.

2.2 MANUFACTURED UNITS

A. Swing Gate Operators:
   1. Model: CSW24UL.
   2. Operation: Gear driven.
   3. Meet UL 325, UL 991, and ASTM F2200.
   4. Motor: 24 VDC, continuous duty type, sized to gate conditions.
   5. Battery backup: Maximum 400 cycles.
   6. Monitoring and controls:
      a. Internet connectivity: MyQ technology with 50 channel FHSS.
b. Built-in Wi-Fi with internet gateway.
7. Monitored retro-reflective photo eyes.
8. Monitored small profile wired safety edge.
10. Model EL2000SS telephone entry system.
11. Seven-day gate operator timer.
12. Three-button encrypted DIP remote controls.
13. Internet gateway.

2.3 ACCESSORIES

A. Linkage: As required by conditions of use.
B. Concrete: ASTM C94; minimum 3000 psi 28 day strength, 2 to 3 inch slump.
C. Loop: Teflon coated copper wire in plastic housing.
D. Loop Groove Filler: Cold-poured rubberized asphalt emulsion.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions and approved Shop Drawings.
B. Set operators on concrete foundation, rigidly connected.
C. Install linkage between operators and gates.
D. Saw cut grooves in pavement for buried sensing loops, install loops and lead wires, and fill grooves flush.
E. Install controls, wiring, conduit, junction boxes, transformers, circuit breakers, and auxiliary components as required. Make connections to power supply and control wiring.

3.2 CLOSEOUT ACTIVITIES

A. Test and adjust operators for proper operation.
B. Demonstration: Demonstrate operation and programming of operators to Owner.

END OF SECTION
SECTION 32 33 00 - SITE FURNISHINGS

PART 1  GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Site furnishings.

B. Related Sections:
   1. Division 01: Administrative, procedural, and temporary work requirements.

1.2 SUBMITTALS

A. Submittals for Review:
   1. Shop Drawings: Indicate locations, dimensions, attachment, and relationship to adjacent construction.
   2. Product Data: Manufacturer's descriptive data.
   3. Samples: 3 x 3 inch samples showing each finish.

PART 2  PRODUCTS

2.1 MANUFACTURED UNITS

A. Site Furnishings: Refer to Materials Legend.

2.2 ACCESSORIES

A. Anchors: Type recommended by furnishing manufacturer for specific application; stainless or corrosion resistant coated steel with vandal resist heads.

PART 3  EXECUTION

3.1 INSTALLATION

A. Install furnishings in accordance with manufacturer's instructions and approved Shop Drawings.

B. Set plumb, level, and rigid.

END OF SECTION 32 33 00
SECTION 32 91 19.16 - TOPSOIL

PART 1 - GENERAL

1.1 SUMMARY:
A. Section Includes
   1. This section specifies all soil material designated as “Topsoil” on the drawings or in
      the specifications.
B. Related Documents
   1. Drawings and General provisions of the Contract, including General and
      Supplementary Conditions and Divisions 1 Specification Sections, apply to
      this Section.
   2. All other Divisions of the Contract Documents. Refer to each Division’s
      Specifications and drawings for all requirements, including but not limited to the
      following:
      a. Earth Moving – Section 31 20 00.
      b. Fine Grading – Section 31 22 16.
      c. Turf and Grasses – Section 32 92 00.
      d. Planting – 32 93 00.

1.2 SUBMITTALS:
A. Samples
   1. Provide 1-quart samples for each soil unit making up the topsoil source.
   2. Each sample to be a composite of five to seven (5-7) sub-samples taken the full
      depth of proposed source. On stockpiles, discard upper 6 inches of soil before
      sampling.
   3. Place samples in plastic bags, seal, and place in second paper bag, and label.
B. Test Reports
   1. Prior to starting work, submit 2 certified copies of soil test reports to the Architect for
      approval.
   2. Costs of all tests to be borne by the Contractor.

1.3 QUALITY ASSURANCE:
B. All soil samples and testing shall comply with procedures specified in:
C. Testing Laboratories
   1. Certified facilities normally engaged in agronomic soil testing shall be utilized.
   2. Approval by the Owner’s representative.
D. Required Topsoil Tests
   1. Chemical analysis indicating:
      a. Fertility: pH, nitrate nitrogen, ammonia nitrogen, phosphate phosphorous,
         potassium, calcium, magnesium, zinc, iron, and manganese.
      b. Suitability: total salinity, boron, sodium, potassium, calcium, magnesium,
         chloride, and sulfate.
   2. Physical properties include:
      a. Organic content
      b. Particle size distribution

PART 2 - PRODUCTS

2.1 TOPSOIL:
A. Topsoil for the work shall conform to the requirements included in this Section.
1. A natural, friable, loamy soil, typical of local topsoil which produces heavy vegetative growth, free from subsoil, weeds, sods, stiff clay, stones larger than ½ inch, toxic substances, debris, or other substances which may be harmful to plant growth.

2. The pH range shall be 6.5 to 7.5.

B. Grading Analysis: Two inch sieve, 100 percent passing. Number 4 sieve, 90 percent minimum passing. Number 10 sieve, 80 percent minimum passing.

C. Sand, silt and clay content:
   1. Sand: 20 to 75 percent.
   2. Silt: 10 to 60 percent.
   3. Clay: 5 to 30 percent.

D. All topsoil shall be free from all herbicides and insecticides which may adversely affect growth of lawn or planting, or which may contain toxic materials.

E. Do not deliver in muddy condition.

F. The Contractor shall not use materials which do not conform to these criteria. At the discretion of the Landscape Architect, such material can either by amended to meet these requirements, or will be removed from the site and replaced with suitable material as specified.

PART 3 – EXECUTION

3.1 Not Used

END OF SECTION 32 91 19.16
PART 1 – GENERAL

1.1 SUMMARY:

A. Section includes:
   1. Furnish all labor, material, equipment related services and supervision necessary for or incidental to the installation of the lawns and grasses as shown or indicated on the Drawings and/or as specified.
   2. Work Included:
      b. Fertilization.
      c. Grass Seeding.
      d. Grass Hydro Mulch.
      e. Grass Sprigging.
      f. Grass Sodding.

B. Related Documents
   1. Drawings and General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   2. All other Divisions of the Contract documents. Refer to each Division’s specifications and drawings for all requirements, including but not limited to the following:
      a. Fine Grading – Section 31 22 16.
      b. Planting - Section 32 93 10.
      c. Planting Maintenance - Section 32 95 10.

1.2 SUBMITTALS:

A. Delivery Receipts and Invoices: Submit original delivery receipts and invoices for materials used.

B. Product Data: Submit sample label or specification of fertilizer.


D. Certificate: Submit State Certificate stating variety and purity of grass sprigs.

E. Certificate: Submit State Certificate stating variety and purity of grass sod.

F. Application Log: Submit daily log sheets of hydro mulch operations with the following information:
   1. Seed type and amount.
   2. Fertilizer analysis and amount.
   3. Mulch type and amount.
   4. Seeding additive type and amount.
   5. Number of loads-amount of water.
   6. Area covered.
   7. Equipment used-capacity and license number.
   8. Signature of nozzle man.

G. Soil Fertility Test Reports:
   1. Submit analysis, test results and corrective recommendations to Architect.
   2. Two tests required of existing soil taken at different locations on the project site as directed by the Architect.

1.3 PROTECTION:

A. Protect paving surfaces, curbs, utilities, plant materials, and other existing improvements from damage by heavy equipment.
B. Locate and stake irrigation heads, valve risers and equipment prior to beginning soil preparation work.
C. Exercise care to prevent the hydromulch slurry from being sprayed inside reservoir basins or drainage ditches and channels which may impede the free flow of rain water runoff or irrigation water.
D. Clean paving and other surfaces of over-spray and spillage of hydro mulch slurry.
E. During work and maintenance period, maintain topsoil in place at established grades. Replace topsoil and grass losses due to erosion.
F. Protect in place work from damage by heavy equipment. Prepare, grade, level and replant damaged areas.

1.4 SUBSTANTIAL COMPLETION & PROJECT CLOSEOUT

A. A Certificate of Substantial Completion will be issued when the Work performed under the Contract has been reviewed and found, to the Architect’s best knowledge, information and belief, to be substantially complete. Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so the Owner can occupy or utilize the Work for its intended use. The date of Substantial Completion of the Project or portion thereof is also the date of commencement of applicable guarantees as specified.
B. A list of items to be completed or corrected will be attached to the Certificate or Substantial Completion. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract documents.
C. The Contractor will complete or correct the Work on the list of items within a specific number of days as shown on the Certificate of Substantial Completion.
D. Upon completion and re-inspection of all corrected items listed, the Architect will recommend to the Owner that the work of this Section is ready for final acceptance.

1.5 QUALITY ASSURANCE:

A. General: Comply with applicable Federal, State, County and local regulations governing landscape materials and work.
B. Personnel: Employ only experienced personnel who are familiar with the required work. Provide supervision by a qualified foreman.

1.6 GUARANTEE:

A. Guarantee lawns and grasses for one year after date of Final Acceptance which is described in paragraph 1.7.D. At the end of this guarantee period, all lawn and grass areas will have achieved coverage of the specified grass at a density of 100% coverage, free of weeds, undesirable grass species, disease and insects. Replace dead materials and materials not in vigorous, thriving condition as soon as weather permits and on notification by the Architect.
B. Replace lawns and grasses with same kind as originally planted, at no cost to the Owner. Protect irrigation system and other piping, conduit or other work during replacement. Repair damage immediately.

1.7 JOB CONDITIONS

A. Do not install seed or sod on saturated or frozen soil.
B. Sod installation shall be subject to suitability of the weather and other conditions affecting sod growth.

1.8 PROGRESS MEETINGS

A. Contractor shall attend all progress meetings as requested by the
1.9 QUANTITY VERIFICATION:

A. The bidding contractor is responsible for the inclusion of all materials, labor and equipment as outlined in the plans and specification. The plant list is provided to the bidding contractor as a convenience and the quantities are approximate. VERIFICATION OF ALL QUANTITIES IS THE SOLE RESPONSIBILITY OF THE BIDDING CONTRACTOR. Any discrepancies must be reported to the Architect prior to submittal of bid.

PART 2 – PRODUCTS

2.1 GRASS:

A. Native Grass Seed: See drawings for selected varieties. Seed shall be harvested within one year prior to planting, free of Johnson grass, field bind weed, dodder seed and free of other weed seed to the limits allowable under the Federal Seed Act and applicable seed laws. The seed shall be hulled, extra fancy grade, treated with fungicide and have a germination and purity that will produce, after allowance for Federal Seed Act tolerances, a pure live seed content of not less than 70%, using the formula: purity % times (germination % times plus hard or sound seed %). Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

B. Wildflower Seed: See drawings for selected varieties. Seed shall be harvested within one year prior to planting, free of Johnson grass, field bind weed, dodder seed and free of other weed seed to the limits allowable under applicable seed laws. The seed shall have a germination and purity that will produce a pure live seed content of not less than 70%, using the formula: purity % times (germination % times plus hard or sound seed %). Seed shall be labeled in accordance with U.S. Department of Agriculture rules and regulations.

C. Seed used shall be labeled and furnished in sealed standard containers with signed copies of a statement from the vendor certifying that each container of seed delivered is fully labeled and is in conformance with the requirements of these specifications.

D. Seed that has become wet, moldy or otherwise damaged in transit or storage will not be accepted.

2.2 EROSION BLANKET:

A. Curlex Blanket manufactured by American Excelsior Company (817 640-2161) or equal.

PART 3 – EXECUTION

3.1 GENERAL:

A. Execute grass planting operations across slope and parallel to finished grade contours.

3.2 SOIL PREPARATION:

A. Tillage:
   1. Tillage shall be accomplished to loosen all areas of compacted soil. When placement of topsoil is specified, till compacted areas prior to placement.
   2. Till with heavy duty disc, rototiller, or chisel-type breaking plow, chisels set not more than 10 inches apart. Till to a depth of 1 to 3 inches.
   3. Initial tillage shall be done in crossing pattern for double coverage then followed by a disc harrow.

B. Cleaning:
1. Remove debris, building materials, rubbish, weeds, and stones larger than 1 inch in diameter.
2. Use Rock Pick or other machinery to gather surface stones larger than 1 inch in diameter.

C. Fine Grading:
1. After tillage and placement of topsoil, level, fine grade, and drag with a weighted spike harrow or float drag.
2. Eliminate ruts, depressions, humps and objectionable soil clods.

3.6 PLANTING SEEDED GRASS AREAS:

A. Apply native grass seed at the rate specified using a no-till grass seed drill or a broadcast spreader. Evenly spread seed over the entire area. If using a broadcast spreader, use a rollerpacker or rake to press the seed into the soil. Most seeds should never be buried more than twice their diameter. Do not bury small seeds.
B. Apply wildflower seed at the rate specified. Spread half the seed evenly over the whole area. Then cross back in the opposite direction and spread the remaining seed evenly over the entire areas. Follow with a rollerpacker or rake to press the seed into the soil.
C. Place erosion Blanket over seeded areas sloped 1 inch to 3 inches and steeper.
D. Anchor Erosion Blanket with wire staples at edges, through center and using trenched in edges per manufacturer recommendation.
E. Water seeded areas to depth of 4 inches.
F. Timing:
   1. Broadcast or drill seed native grass seed from early spring to late summer when soil temperatures are above 65 degrees.
   2. Broadcast wildflower seed from August to late November.

3.3 GRADING:

A. Maintain existing established grades, protect true and even during operations.

3.4 EROSION CONTROL:

A. During work and maintenance period, maintain topsoil in place at established grades. Replace topsoil and turfgrass losses due to erosion.

3.5 CLEAN-UP:

A. Remove excess material and debris from site.

3.6 MAINTENANCE:

A. Until Final Acceptance, maintain lawn and grass areas by watering, mowing, weeding, spraying, cleaning and replacing as necessary to keep the turf and grass in a vigorous, healthy condition.
   1. Watering: As necessary. Provide temporary above ground sprinklers over un-irrigated areas including temporary water meter if required. Water cost will be paid separately by the Owner or General Contractor unless noted differently on the drawings or bid form.
   2. Weeding: Remove weeds and foreign grass over lawn and grass areas at least once a week. Herbicides may be used only when approved by the Owner and Architect.
   3. Follow landscape maintenance procedures outlined in specification section 32 95 10 – Planting Maintenance.

END OF SECTION 32 92 10
PART 1 – GENERAL

1.1 SUMMARY:

A. Section Includes:
   1. Furnish all labor, material, equipment, related services and supervision necessary for or incidental to the installation of the trees, plants and groundcovers as shown or indicated on the Drawings and/or as specified.
   2. Work Included:
      i. Trees.
      ii. Shrubs.
      iii. Groundcovers.
      iv. Steel Edging.
      v. Mulching.
      vi. Bed Preparation.

B. Related documents
   1. Drawings and General provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
   2. All other Divisions of the Contract Documents. Refer to each Division’s specifications and drawings for all requirements, including but not limited to the following:
      i. Fine Grading - Section 31 22 16.
      ii. Turf and Grasses - Section 32 92 10.
      iii. Planting Irrigation - Section 32 94 00.
      iv. Planting Maintenance - Section 32 95 10.

1.2 REFERENCE STANDARDS:


1.3 SUBMITTALS:

A. Delivery Receipts and Invoices: Submit original delivery receipts and invoices for materials used.

B. Product Data: Submit manufacturer’s product data sheets for proprietary products in accordance with Section 01 33 00.

C. Samples:
   1. Submit three samples each of small trees and shrubs for the Architect’s approval. When approved, tag and maintain as representative samples for finally installed plant materials. Samples may be used to complete installation provided they remain tagged until final acceptance of entire installation.
   2. Submit photos of trees and source nursery information to the Architect for review prior to tree tagging. Architect will tag trees at source nursery prior to project delivery.
   3. Submit for approval sufficient representative quantities of sandy loam, composted organic material, steel edging, mulch, peat moss and crushed rock. Samples shall be approved by the Architect before use on project.

D. Soil Fertility Test Reports:
   1. Submit analysis, test results and corrective recommendations to Architect.
   2. Two tests required of existing soil taken at different locations on the project site as directed by the Architect.
3. One test required of the specified composted organic material mixed in equal parts with the existing topsoil.

1.4 DELIVERY, STORAGE AND HANDLING:

A. Deliver packaged materials in containers showing weight, analysis and name of manufacturer.

B. Protect materials from deterioration during delivery and while stored at the site.

1.5 PROJECT CONDITIONS:

A. Site Inspection:
   1. It is the bidding contractor’s responsibility to review all site conditions, as they relate to the proposed project, prior to submission of a bid. Any issues or concerns will be submitted to the Architect prior to bidding. Submission of a bid will indicate that the bidding contractor has made a site inspection.

B. Utilities:
   1. Determine locations of underground utilities and perform work in a manner which will avoid possible damage. Do not permit heavy equipment such as trucks to damage utilities. Hand excavate, as required to minimize possibility of damage to underground utilities. Maintain grade stakes until removal is directed.
   2. Coordinate with irrigation work to prevent damage to temporary risers of underground sprinkling system and obstruction of work located in landscape areas.

C. Protections:
   1. Do not move equipment over existing or newly placed structures without the Architect’s approval.
   2. Provide board roading as required to protect paving and soft soil.
   3. Protect other improvements from damage, with protection boards, ramps and protective sheeting as required.
   4. Locate and stake irrigation heads, valve risers and equipment prior to beginning soil preparation work.
   5. During work and maintenance period, maintain topsoil and prepared soil in place at established grades. Replace topsoil, prepared soil and mulch due to erosion.

D. Delivery and Storage:
   1. Store materials in area covered with protective sheeting.
   2. If balled plants cannot be planted within 24 hours after delivery to site, protect root balls by heeling in with sawdust or other approved material.

1.6 SUBSTANTIAL COMPLETION & PROJECT CLOSEOUT:

A. A Certificate of Substantial Completion will be issued when the Work performed under the Contract has been reviewed and found, to the Architect’s best knowledge, information and belief, to be substantially complete. Substantial Completion is the stage in the progress of the Work when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so the Owner can occupy or utilize the Work for its intended use. The date of Substantial Completion of the Project or portion thereof is also the date of commencement of applicable guarantees as specified.

B. A list of items to be completed or corrected will be attached to the Certificate of Substantial Completion. The failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract Documents.

C. The Contractor will complete or correct the Work on the list of items within a specific number of days as shown on the Certificate of Substantial Completion.

D. Upon completion and re-inspection of all corrected items listed, the Architect will recommend to the Owner that the work of this Section is ready for final acceptance.
1.7 QUALITY ASSURANCE:

A. General: Comply with applicable Federal, state, county and local regulations governing landscape materials and work.
B. Installer Qualifications: The bidding company will specialize in landscape installation with 5 years documented experience. The contractor will staff the project with a competent superintendent and the necessary assistants as approved by the Architect. The superintendent will not be changed except with the consent of the Architect and Owner. The superintendent must have a minimum 5 years experience with similar projects.
C. Personnel: Employ only experience personnel who are familiar with the required work. Provide adequate supervision by a qualified foreman.

1.8 GUARANTEE:

A. Guarantee plants and trees for one year after date of Final Acceptance which is described in paragraph 1.7.D. Replace dead materials and materials not in vigorous, thriving condition as soon as weather permits and on notification by the Architect. Replace plants, including trees, which have partially died thereby damaging shape, size or symmetry.
B. Replace plants and trees with same kind and sizes as originally planted, at no cost to the Owner. At direction of the Architect, trees may be replaced at start of next year’s planting or digging season. In such cases, remove dead trees immediately. Protect irrigation system and other piping, conduit or other work during replacement. Repair damage immediately.

1.9 PROGRESS MEETINGS:

A. Contractor shall attend all progress meetings as requested by the Architect/Owner during installation.

1.10 QUANTITY VERIFICATION:

A. The bidding contractor is responsible for the inclusion of all materials, labor, and equipment as outlined in the plans and specification. The plant list is provided to the bidding contractor as a convenience and the quantities are approximate. VERIFICATION OF ALL QUANTITIES IS THE SOLE RESPONSIBILITY OF THE BIDDING CONTRACTOR. Any discrepancies must be reported to the Landscape Architect prior to submittal of bid.
B. The Contractor is required to install the specified type and quantity of composted organic material purchased from the specified supplier. Soil Building Systems will e-mail the Architect, as orders are being placed, for verification that the specified material, quantity and supplier are being used.

PART 2 – PRODUCTS

2.1 PLANTS:

A. General: Plants shall be well-formed No. 1 grade or better nursery stock in accordance with requirements of reference standards, subject to the Architect’s approval. Listed plant heights are from tops of plant balls to the nominal tops of plants.
B. Shrubs and Groundcovers: Nursery grown, healthy, vigorous, bushy, well branched, of normal habit of growth for species, free from disease, insects, eggs and larvae. Specified sizes shall be before pruning, and plants shall be measured with their branches in normal position. The Architect prior to installation will approve all plants.

C. Ornamental and Shade Trees: Healthy, vigorous, full branches, well shaped, trunk diameter and height requirements as specified. Balls shall be firm, neat, slightly tapered and well burlaped. Trees with loose or broken balls at time of planting shall be rejected. Each tree will be approved by the Architect prior to installation. Balls shall be 10 inches in diameter for each 1 inch of caliper. All balled and burlaped trees and shrubs will be dug and stored for a minimum of 60 days prior to planting on this project. All trees shall have excess soil removed from the top of the root ball so the root flare is exposed.

D. Caliper: Trees 4 inches and less are measured 6 inches above top of root ball. Trees over 4 inches are measured 12 inches above top of root ball.

E. Trees connected to stakes at the nursery are not acceptable and will be rejected.

2.2 SOIL PREPARATION MATERIALS:

A. Sandy Loam: Fertile, dark sandy loam free of rubble, stones, lumps, plant roots and reasonably free of weeds. Loam containing nut grass or Dallisgrass shall be rejected.

B. Commercial Fertilizer: Complete fertilizer, uniform in composition, dry and free flowing. Deliver to site in original unopened containers, each bearing manufacturer’s guaranteed statement of analysis. Lesco 14-14-14 landscape and ornamental fertilizer with micronutrients.

C. Composted Organic Material: Compost with a ph of 5.5 to 6.5 and shall be free of treated or used lumber, pine bark or mushroom compost waste. 97% of the material shall pass through a .5 inch screen and 100% shall pass through a .75 inch screen.

D. Biofiltration Soil: Soil Building Systems “Container Soil” or approved equal.

2.3 BIO-FILTRATION SWALE SOIL MIX:

A. Composition ratio:
   1. 50% Clean Sand
   2. 25% ‘PH Balanced’ Compost
   3. 25% Existing top soil in accordance with Section 32 91 19.16

2.4 MISCELLANEOUS MATERIALS:

A. Crushed Rock: Washed .75 inch to 1.5 inches in diameter.

B. Tree Staking: Tree Stake Solutions
   1. Trees up to 45 gallon – 45 BG
   2. Trees up to 65 gallon – 65 BG
   3. Trees up to 100 gallon – 100BG

C. Mulch: aggregate mulch harvested on site; crush and sieve to 1/4” – 1/2” graded mix.

D. Filter Fabric: Mirafi 140N by Celanese Fibers Marketing Co. or equal.

E. Fertilizer Tablets: BioPlex Planting Tablets, 15 gram, 12-8-8. BioPlex @ 1-800-441-3573

F. Steel Edging: not applicable.

G. 4 inch PVC pipe and cap CUA 55 200.

H. Water: Provided by Owner.

I. Technical Concentrate and Plant Enhancer: BioPlex @ 1-800-441-3573

J. Pre-Emergent Herbicide: Barracade or Pre-M.

PART 3 – EXECUTION
3.1 EXAMINATION AND PREPARATION:

A. Examine sub-grade and other related construction for defects that adversely affect work.
B. Do not proceed until unsatisfactory conditions have been corrected.
C. Plant trees and shrubs during normal seasons for such work in the project location and only when weather conditions are suitable.
D. Plant trees and shrubs after final grades are established and prior to planting of lawns.
E. Additional soil amendments may be required per soil test results.

3.2 BED PREPARATION:

A. When grassy or broadleaf weeds are present, spray with Roundup, a non-selective systemic herbicide, for 100% control. When Nut Sedge is present, spray with Manage, a selective post emergent herbicide, for 100% control. Application of post emergent herbicides is to be performed by a licensed applicator.
B. Layout and stake beds for Architect’s approval prior to installation of steel edging and planting.
C. Excavate existing soil from beds as needed to allow for installation of the specified organic compost and mulch. Excavated materials will be removed from the site as required by the Architect and Owner.
D. Provide 4 inches of composted organic material in shrub and groundcover beds.
E. Till to a depth of 8 inches.
F. Add commercial fertilizer at 7 pounds per 1,000 square feet of bed area and apply prior to application of mulch.
   1. The fertilizer type and rate specified herein is applicable unless countermanded by the soil fertility test corrective recommendations, in which case they will be applicable.
G. Grade beds to allow for free flow of surface water to the bed edge and away from buildings. Beds will be mounded 2 inches to 3 inches and tapered at the edges to meet existing grade.

3.3 SHRUB AND GROUNDCOVER SPACING:

A. Place plants in position on bed areas before containers have been removed. Obtain approval from Architect. Do not remove burlap from shrubs.
B. Plant where located, setting plants with tops of balls even with tops of beds, and compact soil carefully around each plant ball.
C. Remove binding materials (such as twine, nylon cord, and wire) from plant trunk.
D. Water each plant thoroughly with hoses to eliminate air pockets.
E. Carefully prune plants to remove dead or broken branches and hand-rake bed areas to smooth, uneven surfaces.
F. Architect reserves the right to interchange or shift locations of plants prior to planting.
G. Apply pre-emergent herbicide, at the recommended rate, three weeks after plant installation has been completed and prior to mulch installation.

3.4 PLANTING:

A. Ornamental Trees and Large Shrubs:
1. Plant trees and shrubs in pits 3 times greater in diameter than root ball. Top 1/3 of backfill will be 20% compost mixed with 80% native soil. Bottom 2/3 of backfill will be 100% native soil. Carefully settle by watering to prevent air pockets.

2. Add fertilizer tablets at the rate of four (4) per 1 inch caliper for trees and four (4) per 24 inches of height for large shrubs. Follow label directions for placement of tablets.

3. Carefully prune trees to remove dead and broken branches.

4. Place root ball in the center of the hole. Do not handle tree by the trunk to place in hole. Scarify and roughen sides of hole where glazed by mechanical excavation.

5. Make sure the root flare is 2 inches higher than the adjacent soil elevation. The top of the terminal roots at the outer edge of the root ball should be even with or slightly higher than the adjacent soil elevation. Set root ball on undisturbed soil.

B. Shade Trees:
   1. Plant trees in pits 3 times greater in diameter than root ball. Top 1/3 of backfill will be 20% compost mixed with 80% native soil. Bottom 2/3 of backfill will be 100% native soil. Carefully settle by watering to prevent air pockets.
   2. Add four (4) fertilizer tablets per caliper inch. Follow label directions for placement of tablets.
   3. Carefully prune trees to remove dead and broken branches.
   4. Place root ball in the center of the hole. Do not handle tree by the trunk to place in hole. Scarify and roughen sides hole where glazed by mechanical excavation.
   5. Make sure the root flare is 2 inches higher than the adjacent soil elevation. The top of the terminal roots at the outer edge of the root ball should be even with or slightly higher than the adjacent soil elevation. Set root ball on undisturbed soil.

C. Shrubs Outside Of Beds:
   1. Plant shrubs in pits as sized below. Backfill mix will be 50% existing soil and 50% compost. Excess excavated material will be removed from the site as required by the Landscape Architect and Owner. Set root ball on undisturbed soil.

   Container Size | Pit Size
   ---------------|------------
   1 Gallon       | 10" Diameter x 8" Depth
   2 Gallon       | 14" Diameter x 10" Depth
   3 Gallon       | 16" Diameter x 12" Depth
   5 Gallon       | 20" Diameter x 14" Depth
   7 Gallon       | 24" Diameter x 16" Depth

   2. Add fertilizer tablets at the rate of four (4) tablets per 24 inches of plant height. Place tablets. Follow label directions for placement of tablets.
   3. Carefully prune plants to remove dead and broken branches.

3.5 SUMMER DIGGING & TRANSPLANTING:

   A. To minimize transplant shock, plant decline, defoliation or loss to all balled and burlaped plants.
   1. Apply Technical Concentrate and Plant Enhancer to plants 24 to 96 hours prior to digging or transplanting.
   2. Apply with both a foliar and root drench at identical dilutions of 1.0 fl. oz. (low stress conditions) to 3.0 fl. oz. (high stress conditions) per inch of trunk diameter or each 24 inches of plant height. Mix into 5 to 10 gallons of water for each 1 inch of trunk diameter and 24 inches of plant height.
   3. Re-apply in 15 to 30 days or sooner if extreme environmental stress requires. Re-apply at either a rate of 1 to 3 fl. oz. per inch of trunk diameter or 5 to 7 fl. oz. per 5 to 10 gallons of water.

3.6 TREE SUMPS:

   A. Perform percolation test for each tree pit and install sump detail only when satisfactory
drainage does not occur within 24 hours.

B. Excavate sump pit to a minimum depth of 4 feet 6 inches below bottom of root ball and a minimum of 12 inch diameter.

C. Install 4 inch diameter PVC pipe and cap. The portion of pipe in crushed rock is to be perforated.

D. Place crushed rock per tree planting detail.

E. Place filter fabric over top of crushed rock and 12 inches up side of tree pit.

F. Paint PVC cap, color to be selected. Drill 5/8 inch diameter hole in top of cap.

3.7 GUING TREES:

A. Guy trees immediately after planting as shown on planting details.

B. All conifer and juniper variety of trees will be guyed per the tree planting detail.

C. All container grown and containerized trees will be guyed per the tree planting detail.

D. All balled and burlaped trees will be guyed per the tree planting detail.

E. It will be the Landscape Contractor’s responsibility to maintain trees in a plumb position through the warranty period whether they are guyed or not.

F. The landscape contractor will remove and dispose of tree guying materials at the end of the one year guarantee period.

3.8 MULCHING:

A. After planting has been completed and approved by Architect, cover all bare soil around plants. The depth shall vary depending on the plants being mulched. Large plants will receive a 2 inch depth and plants in 4 inch pots and smaller will receive a 1 inch depth. At no time will mulch come in contact with the stems of plants. Delay mulching in shrub beds until after application of pre-emergent herbicide and near substantial completion of the project.

3.9 STEEL EDGING:

A. Install steel edging. Anchor with steel stakes, 16 inches in length minimum, spaced not more than 30 inches on center and driven at least 1 inch below top of edging. The top of edging will be 1 inch above the adjacent turf elevation.

3.10 CLEANUP:

A. During work, keep premises neat and orderly including organization of storage areas. Trash, including debris resulting from removing weeds or rocks from planting areas, preparing beds, or planting plants, shall be removed from site daily as work progresses.

B. Keep sidewalks, streets and courtyard areas clean by sweeping or hosing.

3.11 MAINTENANCE:

A. Water will be provided by the Owner. Provide necessary hoses and other watering equipment required to complete work.

B. Until Final Acceptance, maintain plantings and trees by watering, cultivating, weeding, spraying, cleaning and replacing as necessary to keep the landscape in a vigorous, healthy condition and rake bed areas as required.

C. Follow landscape maintenance procedures outlined in Specification Section 32 95 10 – Landscape Maintenance.

3.12 PLANT SCHEDULE:

A. Refer to schedule on drawings.
SECTION 32 95 00 – PLANTING MAINTENANCE

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Landscape Maintenance Contractor shall furnish all labor, equipment and products necessary to maintain newly planted landscaping leaving plants in a vigorous, healthy state through the end of the stated maintenance period. This organic maintenance program shall consist of watering, weeding, fertilizing, disease and insect pest control, pruning, aerating, protective spraying and any other procedures consistent with good organic horticultural practices necessary to insure normal, vigorous and healthy growth of all landscape materials under this contract. Trash and debris will be removed from the project during each regular site visit. Maintenance shall begin following final acceptance of the landscape installation.

B. The Landscape Maintenance Contractor shall be responsible for the use of all his/her materials, labor and equipment. Injury to plant material caused by such maintenance, labor and equipment shall be corrected and repaired by the Landscape Maintenance Contractor at his/her expense. This includes both reseeding areas damaged by tractor treads when mowing is conducted at an inappropriate time, as determined by the Owner or his/her agent, and replacement of any plants, hardscape, or other amenities on the site when damaged by the Contractor’s equipment, materials or agent(s).

1.03 INSURANCE:

A. Contractor shall provide to the Owner, at his own expense, evidence of adequate Workman's Compensation, General Liability and Property Damage Liability, subject to approval of the Owner.

1.04 CLEAN UP:

A. All debris, tools, surplus materials, equipment, etc. shall be removed after each regular visit from the maintenance crew. The site shall be left in a neat, acceptable condition such as to meet the approval of the Owner.

1.05 LICENSE REQUIREMENTS:

A. Pesticide: The Contractor shall be a licensed pesticide applicator or employ a licensed certified pesticide applicator for the treatment of insects and diseases as required by the Texas Pesticide Laws and Regulations of the Texas Department of Agriculture. The Owner may require documentation of such certification as necessary for his records.

B. Herbicide: The Contractor shall possess a permit or employ a person who possesses a permit to apply herbicide as required by the Texas Herbicide Law of the Texas Department of Agriculture. The Owner may require documentation of such certification as necessary for his records.
C. Irrigation: The Contractor shall possess an irrigator’s license issued by the State of Texas and the Texas Board of Irrigators or employ such a licensed irrigator to perform the irrigation system maintenance. The irrigation system shall be maintained under the supervision of the licensed irrigator who shall be on the site at all times during this work. The Owner may require documentation of such license for his records. The Contractor shall verify and adhere to the requirements and codes of any controlling utility authorities.

PART 2 - PRODUCTS

2.01 COMMERCIAL FERTILIZER:

A. Complete fertilizer, uniform with composition, dry and free flowing, delivered to site in original unopened containers, each bearing manufacturer’s guaranteed statement of analysis.
   1. Shrubs & groundcover at 10-20-10 analysis.
   2. Trees at 32-7-7 analysis (Injecto-Feed).
   3. Trees at 0-4-4 analysis (Agri-Plex).

2.02 SOIL FERTILITY TEST:

B. The Contractor will be required to furnish the Owner with two (2) soil fertility reports including corrective recommendations.
C. The exact location of each soil sample taken will be provided by the Architect or Owner.
D. Soil fertility testing will be conducted by a laboratory making organic recommendations. Texas Plant and Soil Lab, E. K. Chandler, 5115 W. Monte Cristo Rd., Edinburg, TX 78539, (956) 383-07399 (must ask for organic recommendations).

2.03 MULCH:

A. Harvested on site; crush and sieve to 1/4" - 1/2" graded mix, install in 1" lifts to 2" depth.

2.04 WATER:

A. Water will be supplied by the Owner.

2.05 PLANT REPLACEMENT:

A. It will be the responsibility of the Contractor to replace any and all plant material that is dead or damaged due to non-performance of the contracted scope of work, un-supervised personnel or un-supervised subcontractors.

2.06 PESTICIDES AND HERBICIDES:

A. Pesticides and herbicides shall be of the type that is commercially available.

PART 3 - EXECUTION

3.01 TREE, SHRUB AND GROUNDCOVER MAINTENANCE:

A. The Scope of Work for plant maintenance includes all possible means required to preserve the plants and vegetative material existing within the site in a healthy and
vigorous growing condition to insure their successful establishment. Plant maintenance shall include, as a minimum, the following items.

1. Pruning: All trees and shrubs, within the limits of landscape maintenance, shall be pruned by the Contractor to the satisfaction of the Owner. Pruning shall be done in accordance with accepted pruning practices as set forth by the National Arborist Association in Pruning Standards for Shade Trees (current edition). Dead or damaged limbs on trees and shrubs, including sucker-growth on trunks of trees, are to be removed. Crape Myrtles will be pruned in late winter only to remove dead wood, crossing limbs and ground suckers. Suckers will be removed as needed throughout the year. All pruned materials shall become the property of the Contractor and shall be disposed of in a manner acceptable to the Owner. Unless directed differently in the contract documents, pruning shall be accomplished once during the term of this contract.

2. Insect, Disease, and Animal Control: The Contractor shall inspect the plants and planted areas once each two (2) weeks or as approved by the Owner. The Contractor shall be required to notify the Owner in writing of problems with insects, diseases, or animals as such problems arise. The Contractor also shall recommend corrective measures in writing.

3. The Contractor shall treat the plants and/or the planted areas in accordance with accepted methods of horticultural practices and the Texas Department of Agriculture guidelines regarding the use of pesticides. The Contractor also shall follow the manufacturer’s instructions for the use and application of any pesticides.

4. Bed Maintenance: The Contractor shall maintain the plant basins and beds free of weeds and grass or other material detrimental to the growth of the plants or appearance at the site. Herbicides, when used by the Contractor, will under no circumstances be used on days where the wind could cause drift hazard to desirable plants. The Contractor shall also follow the manufacturer’s instructions for the use and application of any herbicide. Two pre-emergent herbicide applications will be made per year along with manual weeding and post emergent herbicide applications as required. All shrub and groundcover beds shall be fertilized two (2) times per year at a rate of 2 lbs. Per 1,000 square feet. Aggregate mulch shall be maintained to a minimum depth of two (2) inches, in all bed areas.

5. Re-staking, re-guying, and re-bracing of Plants: Any damaged or destroyed stakes, guys or braces shall be replaced by the Contractor. This shall include any adjustment to the staking or guying to prevent girdling of plants. Adjustment will be made to tighten wires and cables as required.

6. Tree Mulching and Fertilization:
   a. Maintain a 2” layer of aggregate mulch over all tree root balls in turf areas. Add new mulch as required.
   b. Deep root fertilize all trees with a combination of Injecto-Feed 32-7-7 and Agri-Plex 0-4-4 with 2 percent magnesium, 2 percent water soluble magnesium, 3 percent sulfur, .02 percent boron, 5 percent iron, .5 percent manganese and .5 percent zinc. Mix 20 pounds of Injecto-Feed and 1 gallon of Agri-Plex in 100 gallons of water. Apply this solution at the rate of 5 gallons per inch trunk diameter measured at breast height. Space injection points at 2.5 foot intervals starting 2 feet beyond the drip line. Apply .5 gallon of solution per injection site. Soil injections should be made 6 to 8 inches deep using an injector probe at 150 to 200 PSI. Keep fertilizer solution agitated during application. Where trees are closely spaced and have overlapping treatment areas, inject only once in those areas. Do not double inject these areas. For trees growing in wells surrounded by concrete, water or other hard surfaces, drench the top of the root ball with 10 to 15 gallons of fertilizer solution.
END OF SECTION 32 95 10
PART 1  GENERAL

1.1  SUMMARY

A.  Section Includes:
   1.  Area drains.
   2.  Drain lines.

B.  Related Sections:
   1.  Division 01: Administrative, procedural, and temporary work requirements.

1.2  REFERENCES

A.  ASTM International (ASTM):

1.3  SUBMITTALS

A.  Submittals for Review:
   1.  Shop Drawings: Show layout of drainage fittings and lines, including locations, elevations, slopes, pipe sizes, and accessories.
   2.  Product Data: Manufacturer's data for drain fittings showing physical properties and installation procedures.

PART 2  PRODUCTS

2.1  MATERIALS

A.  Drainage Pipe:
   1.  ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot style solvent sealed ends, non-perforated.
   2.  Fittings: PVC.

B.  Drain Fittings: Refer to Materials Legend.

PART 3  EXECUTION

3.1  EXCAVATION

A.  Trench for drainage pipe.

B.  Hand trim excavations to required shape and elevations.

C.  Remove large stones and obstructions.
3.2 INSTALLATION

A. Install drainage pipe and fittings in accordance with manufacturer's instructions, at required flow line and grade.

B. Provide minimum 0.5 percent uniform slope.

C. Solvent weld joints.

D. Place drain fittings in accordance with manufacturer’s instructions.

E. Backfill and compact without damage to pipe or fittings.

3.3 FIELD QUALITY CONTROL

A. Test drain fittings and drainage lines for free flow prior to covering.

B. If free flow is not present, remove obstructions and repeat test.

END OF SECTION 33 43 00